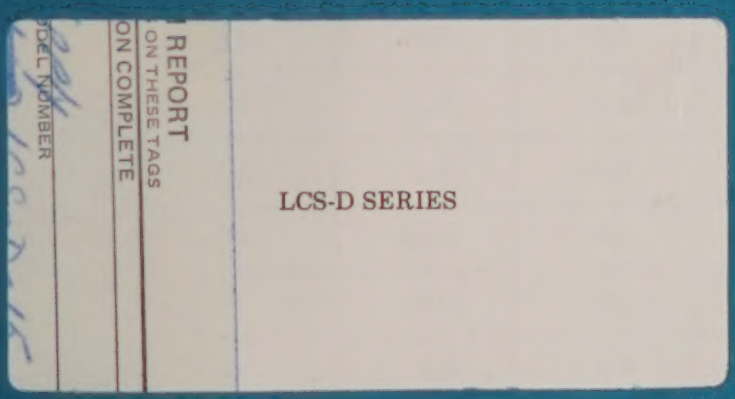
INSTRUCTION MANUAL

REGULATED POWER SUPPLIES



LAMBDA

LAMBDA ELECTRONICS MELVILLE, L. I., N. Y.

INSTRUCTION MANUAL
FOR
REGULATED POWER SUPPLIES

LCS-D SERIES

This manual provides instructions intended for the operation of Lambda power supplies, and is not to be reproduced without the written consent of Lambda Electronics. All information contained herein applies to all LCS-D models unless otherwise specified.

LAMBDA ELECTRONICS MELVILLE, L.I., N.Y.
MAIN PLANT TELEPHONE: 516 MYrtle 4-4200

TABLE OF CONTENTS

Section	Page
SPECIFICATIONS AND FEATURES	1
THEORY OF OPERATION	4
OPERATING INSTRUCTION	6
Basic Mode Of Operation	6
Connections For Operation	6
Supply-Load Connections	6
Operation After Protective Device Shutdown	7
MAINTENANCE	8
General	8
Trouble Analysis	8
Checking Transistors & Capacitors	8
Printed Circuit Board Maintenance Techniques	8
Trouble Chart	9
Performance Checks	10
Adjustment Of Calibration Control R13	10
SERVICE	11
PARTS ORDERING	11

SPECIFICATIONS AND FEATURES

Specifications apply for all models

DC OUTPUT — Voltage regulated for line and load.

TABLE I
VOLTAGE AND CURRENT
RANGES

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
LCS-D-2	2 ±5%	27.5	24.2	20.5	16.5
LCS-D-5-OV	5 ±5%	27.5	24.2	20.5	16.5
LCS-D-6	6 ±5%	26.5	23.4	19.8	16.0
LCS-D-12	12 ±5%	16.0	14.0	11.9	8.0
LCS-D-15	15 ±5%	14.0	12.3	10.4	7.5
LCS-D-20	20 ±5%	11.5	10.0	8.6	6.8
LCS-D-24	24 ±5%	10.0	8.8	7.5	6.0
LCS-D-28	28 ±5%	9.0	8.0	6.8	5.5
LCS-D-48	48 ±5%	5.2	4.7	4.1	3.4
LCS-D-01	0-7	12.5	11.2	9.7	8.0
LCS-D-02	0-18	5.2	4.7	4.1	3.4
LCS-D-03	0-32	3.1	2.8	2.4	2.0

Current range must be chosen to suit the appropriate maximum ambient temperature. Current ratings apply for entire voltage range.

REGULATED VOLTAGE OUTPUT

Regulation (line) ..... 0.01 percent plus 1.0 millivolt for input variations from 105-132 or 132-105 volts AC.

Regulation (load) ..... 0.01 percent plus 1.0 millivolt for load variations from no load to full load or full load to no load.

Remote Programming

External Resistor	Nominal 1000 ohms/volt output
Programming Voltage	One-to-one voltage change
Ripple and Noise	250 microvolts rms; 1 millivolt peak to peak with either positive or negative terminal grounded, 57-63 Hz input
Temperature Coefficient	Output change in voltage (0.01% + 0.3 mv) /°C
Remote Sensing	Provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.

AC INPUT — 105-132, 205-265 or 187-242 ("V" option) volts AC at 47-440 Hz. Input power: 460 watts* For operation at 47-53 Hz, derate current 10% for each ambient temperature given in table I. For 63-440 Hz operation, consult factory.

*With output loaded to full current rating and input voltage 132 volts AC, 60 Hz.

OVERLOAD PROTECTION

Thermal	Thermostat, resets automatically when over temperature condition is eliminated
Electrical	
External	Automatic electronic current limiting circuit, limits output current to a preset value less than 110% of 40°C current rating. Automatic current limiting protects the load and power supply when external overloads and direct shorts occur.
Internal (LCS-D-5-OV, LCS-D-6 only)	Circuit breaker CB1, provides protection against internal circuit failure.

OVERVOLTAGE PROTECTION — Model LCS-D-5-OV includes a fixed built in overvoltage protection circuit which prevents damage to the load caused by excessive power supply output voltage. Overvoltage protection firing range is between 6.2 and 7.4 volts D.C.

INPUT AND OUTPUT CONNECTIONS — Terminal block on rear of chassis.

OPERATING AMBIENT TEMPERATURE RANGE AND DUTY CYCLE — Continuous duty from -20°C to 71°C ambient with corresponding load current ratings for all modes of operation.

STORAGE TEMPERATURE — -55°C to 85°C (non-operating)

CONTROLS

DC output control	Voltage adjust control permits adjustment of DC output voltage via access hole located in nameplate.

PHYSICAL DATA

Size	4-15/16" x 7-1/2" x 9-3/8"
Weight	23 lbs. net; 26 lbs. shipping
Finish	Grey, FED. STD. 595 No. 26081

MOUNTING — Three surfaces, each with tapped mounting holes, can be utilized for mounting this unit. All LCS-D power supplies can be mounted with Top, Front, or Right Side facing up. Top, Front, or Right Side must be in a horizontal plane. Refer to figure 12 for mounting details.

MODEL OPTIONS

"J" Option	Standard LCS-D power supplies can be obtained for 90-110 VAC, 47-440 Hz input. For operation at 47-53 Hz, derate current 10% for each ambient temperature given in table I. For 63-440 Hz operation, consult factory.
"V" Option	Standard LCS-D power supplies can be obtained for 205-265 VAC, 47-440 Hz input or 187-242 VAC, 47-440 Hz input. See nameplate for AC input rating. See schematic diagram for rewiring of AC input. For operation at 47-53 Hz, derate current 10% for each ambient temperature given in table I. For 63-440 Hz operation, consult factory.
"S" Option (LCS-D-5-OV — LCS-D-48 Only)	Fixed voltage LCS-D power supplies must be specified with the "S" option when used with the Systems Power Sequencer. On units with "S" option, resistor R20 is jumped, see schematic diagram.

ACCESSORIES

Rack Adapters	Rack adapters LRA-6, LRA-10, LRA-11 and LRA-13 used for ruggedized mounting with or without chassis slides are available.
Overvoltage Protectors	Externally mounted, Overvoltage Protectors LMOV-1, LMOV-2, and LMOV-3 are available for use with models LCS-D-2 and LCS-D-6 through LCS-D-48 power supplies. On models LCS-D-01 through LCS-D-03, use Overvoltage Protectors LHOV-4 and LHOV-5.
Metered and Non-Metered Panels	Metered panel MP-50 and Non-Metered panel P-50 are available for use with Lambda rack adapters LRA-6 or LRA-7.

THEORY OF OPERATION

GENERAL

The Lambda power supply consists of an AC input circuit and transformer; a bias supply consisting of an auxiliary rectifier, and preregulator*; a drive supply consisting of a rectifier and filter**; a main regulator circuit consisting of the main rectifier and filter, a series regulator, emitter follower driver, a current comparator*, a voltage comparator*, an amplifier*, current and voltage sensing networks and a voltage reference circuit*.

* This circuit element is part of integrated circuit (IC1) in the supply.
** LCS-D-2, LCS-D-5-OV, LCS-D-6, and LCS-D-01 only.

The circuit arrangement is shown in block diagram form, Figure 11. The circuitry is discussed with reference to the block diagram and the schematic diagram.

FUNCTIONAL DESCRIPTION

Single phase input power is applied to transformer T1 through the input circuit which contains a thermostat to protect the supply against over heating.

The main rectifier, a full wave rectifier, provides the power which is filtered by capacitor C6 and, as applicable C7, and then regulated via a series regulator and delivered to the output. Half-wave auxiliary rectifier CR1 provides voltage filtered by capacitor C1 for the preregulator located in IC1. The reference element, powered by the preregulator, provides a reference voltage for the current comparator and the voltage comparator. Full wave drive rectifier CR23, CR24 provides voltage filtered by capacitor C34 for drivers Q1, Q2.

Constant voltage circuit operation is determined by changes in the load which cause a change in one input to the voltage comparator. A second input to comparator is a reference voltage that is developed by a constant current of 1 milliampere flowing in divider element R8, and, as applicable, R20. The comparator compares the output voltage change with reference voltage resulting in an error signal at the output of the comparator.

The error signal from the comparator is then current amplified by drivers Q1 and Q2. The amplified signal from the drivers controls the voltage across the series regulators Q6 through Q11, which function as the active regulating elements in the supply.

* Current limit circuit operation for models LCS-D-2 through LCS-D-48 is determined by changes in the load. The current comparator samples load current through current sensing resistor R25. When the voltage drop across R25 increases to the preset voltage reference determined by R6, R9, R13, and R21, the current comparator conducts. Thus, when the output current rating of the unit is exceeded, the current comparator conducts, decreasing the current through drivers Q1 and Q2, resulting in an increase of voltage across the series regulator and a decrease of the output voltage, effectively limiting the output current to a safe value. The current limit value is determined by fixed resistors R6, R7, R9, R21, and variable resistor R13.

When operating conditions approach short circuit, the output voltage decreases. Since the voltage determined by R13 is proportional to the output voltage, when the output voltage decreases, the amplifier is biased into turn on at lower and lower load currents until output voltage decreases to zero and current decreases to a predetermined low value.

* The following theory applies to models LCS-D-01 through LCS-D-03.

Current limit circuit operation is determined by changes in the load. When load current increases above the rated current value, the voltage drop across current limit potentiometer R13 increases causing the amplifier to turn on. With the amplifier conducting the current to driver Q1 and Q2, decreases, limiting the base current to series regulators Q6 through Q11 which results in an increase of voltage across the series regulators and a decrease of the output voltage, effectively limiting the output current to a safe value. The current limit value is determined by the factory setting of current limit potentiometer R13.

When operating conditions reach short circuit, the output voltage value decreases to zero and the current remains at the current limit value.

OV CIRCUIT, FUNCTIONAL DESCRIPTION (LCS-D-5-OV ONLY)

When the power supply output voltage increases above zener breakdown voltage of CR28 (approximately 6.2 volts) and gate voltage of SCR1 (approximately 0.6 volts), CR28 conducts and current is supplied to the gate of SCR1. SCR1 fires, causing the power supply output voltage to drop.

BASIC MODE OF OPERATION

This power supply operates as a constant voltage source provided the load current does not exceed the rated value at 40°C. For continuous operation, load current must not exceed the rating for each ambient temperature and will remain limited to less than 110% of 40°C rating.

CONNECTIONS FOR OPERATION

NOTE: Make all connections to the unit before applying AC input power.

Ground Connections. The Lambda power supply can be operated either with negative or positive output terminal grounded. Both positive and negative ground connections are shown in the diagrams for all suggested output connections illustrated in this manual.

Connection Terminals. Make all connections to the supply at the terminal block on the rear of the supply. Apply input power to terminals 1 and 2; always connect the ungrounded (hot) lead to terminal 1.

The supply positive terminal is brought out to terminal 6. The supply negative terminal is brought out to terminal 4. Recommended wiring of the power supply to the load and selection of wiring is shown in figures 1 through 10. Selection of proper wiring is made on the basis of load requirements. Make all performance checks and measurements of current or voltage at the rear output terminals. Connect measuring devices directly to terminals or use the shortest leads possible.

SUPPLY LOAD CONNECTIONS

Connections For Operation as a Constant Voltage Source

The output impedance and regulation of the power supply at the load may change when using the supply as a constant voltage source and connecting leads of practical length are used. To minimize the effect of the output leads on these characteristics, remote sensing is used. Recommended types of supply-load connections with local or remote sensing are described in the following paragraphs.

Refer to figure 1 to determine voltage drop for particular cable length, wire size and current conditions. Lead lengths must be measured from supply terminals to load terminals as shown in figure 2.

Local Sensing Connection, Figure 3. The local sensing connection is the connection suitable for applications with relatively constant load.

Remote Sensing Connection, Figure 4. The remote sensing connection provides complete compensation for the DC voltage drops in the connecting cables. Sensing leads should be a twisted pair to minimize AC pick-up. A 2.5 mf, elect., capacitor may be required between output terminals and sense terminals to reduce noise pick-up.

Programmed Voltage Connections. Using External Resistor, Figure 5. Discrete voltage steps can be programmed with a resistance voltage divider valued at 1000 ohms/volt and a shorting-type switch as shown in Figure 5. When continuous voltage variations are required, use a variable resistor with the same 1000 ohms/volt ratio in place of the resistive voltage divider and shorting-type switch. Use a low temperature coefficient resistor to assure most stable operation. Before programming, adjust programming resistor for zero resistance.

As shown in figure 5, voltages can be programmed utilizing either local or remote sensing connections, as desired.

Programmed Voltage Connections Using Programming Voltage, Fig. 6. The power supply voltage output can be programmed with an externally connected programming power supply. The output voltage of the programmed supply will maintain a one-to-one ratio with the voltage of the programming supply.

The programming supply must have a reverse current capability of 1.5 ma minimum.

Alternatively, when supplies with less than 1.5 ma reverse current capability are used, a resistor capable of drawing 1.5 ma at the minimum programming voltage must be connected across the output terminals of the supply. This programming supply must be rated to handle all excess resistor current at the maximum programming voltage.

Connections For Series Operation

The voltage capability of LCS-D power supplies can be extended by series operation. A maximum of 300 volts can be connected between either the +DC or -DC terminal and chassis ground.

Figure 7, and as applicable, 8, shows the connections for either local or remote sensing in a series connection where the voltage control of each unit functions independently to control the output.

Figure 7 applies only to the LCS-D-01 through LCS-D-03 power supplies. If a common load is used, the maximum current rating of the unit with the lower current rating must not be exceeded.

Figure 8 shows the series connection applicable to the LCS-D-2 through LCS-D-48 power supplies. A diode, having a current carrying capability equal to or greater than the maximum current rating of the supply, must be used and connected as shown in figure 8. The diode blocking voltage should be at least twice the maximum rated output voltage of the supply. See table I, of "Specifications and Features" for power supply current and voltage ratings.

Connections For Parallel Operation (Applicable only to LCS-D-01 — LCS-D-03)

The current capability of LCS-D power supplies can be extended by parallel operation of LCS-D power supplies of equal* voltage capacities. Units "M" and "S" are shown connected for parallel operation in figures 9 and 10. One power supply designated the "M" unit controls its own output as well as the output of the second power supply, designated the "S" unit.

* For applications using supplies of unequal voltage ratings, consult factory for details of operation.

Unit S operates to regulate its current in a ratio to that of the M unit by comparing the current in its internal sampling resistor with that current sampled by the master internal sampling resistor.

OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

Thermostat Shutdown

The thermostat opens the input circuit only when the temperature of the internal heat sink exceeds a maximum safe value. The thermostat will automatically reset when the temperature of the heat sink decreases to a safe operating value. After eliminating the cause(s) for overheating and allowing time for the power supply to cool to a proper temperature, resume operation of the supply.

Overvoltage Shutdown

When the power supply output voltage increases above the overvoltage limit, SCR1 will short circuit output of the supply. After eliminating the cause(s) for overvoltage, resume operation of the supply by momentarily interrupting the AC input circuit.

Circuit Breaker Shutdown (LCS-D-5-OV and LCS-D-6 only)

If a malfunction occurs in the power supply causing an overvoltage condition, CB1 will open and prevent excessive current from damaging the load and power supply. If an overvoltage condition arises due to operator error or inadequate output connection, CB1 will not be energized and power supply will operate in the normal current limiting mode. The circuit breaker will trip when the maximum rated current value for the circuit breaker is exceeded. If CB1 trips, check for cause and repair as necessary. To resume operation, place CB1 in ON position.

GENERAL

This section describes trouble analysis routine, replacement procedures, calibration and test procedures that are useful for servicing the Lambda LCS-D power supply. A trouble chart is provided as an aid for the trouble shooter. Refer to the section on specifications and features for the minimum performance standards.

TROUBLE ANALYSIS

Whenever trouble occurs, systematically check fuse, primary power lines, external circuit elements, and external wiring for malfunction before trouble shooting the equipment. Failures and malfunctions often can be traced to simple causes such as improper jumper and supply-load connections or fuse failure due to metal fatigue.

Use the electrical schematic diagram and block diagram, figure 12, as an aid to locating trouble causes. The schematic diagram contains various circuit voltages that are averages for normal operation. Measure these voltages using the conditions for measurement specified on the schematic diagram. Use measuring probes carefully to avoid causing short circuits and damaging circuit components.

CHECKING TRANSISTORS AND CAPACITORS

Check transistors with an instrument that has a highly limited current capability. Observe proper polarity to avoid error in measurement. The forward transistor resistance is low but never zero; backward resistance is always higher than the forward resistance.

For good transistors, the forward resistance for any junction is always greater than zero.

Do not assume trouble is eliminated when only one part is replaced. This is especially true when one transistor fails, causing other transistors to fail. Replacing only one transistor and turning power on, before checking for additional defective components could damage the replaced component.

When soldering semi-conductor devices, wherever possible, hold the lead being soldered with a pair of pliers placed between the component and the solder joint to provide an effective heat sink.

NOTE: The leakage resistance obtained from a simple resistance check of a capacitor is not always an indication of a faulty capacitor. In all cases the capacitors are shunted with resistances, some of which have low values. Only a dead short is a true indication of a shorted capacitor.

PRINTED CIRCUIT BOARD MAINTENANCE TECHNIQUES

1. If foil is intact but not covered with solder, it is a good contact. Do not attempt to cover with solder.

2. Voltage measurements can be made from either side of the board. Use a needlepoint probe to penetrate to the wiring whenever a protective coating is used on the wiring. A brass probe can be soldered to an alligator clip adapted to the measuring instrument.

3. Wherever possible use a heat sink when soldering transistors.

4. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.

5. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process described below:

a) Select a 3/16 inch tinned copper braid for use as a wick. If braid is not available, select AWG No. 14 or No. 16 stranded wire with 1-2 inch insulation removed.

b) Dip the wick in liquid rosin flux.

c) Place the wick onto the soldered connection and apply soldering iron onto the wick.

d) When sufficient amount of solder flows onto the wick, freeing the component, simultaneously remove iron and wick.

TROUBLE CHART

The trouble chart is intended as a guide for locating trouble causes, and is used along with the schematic diagram.

The operating conditions assumed for the trouble chart are as follows:

a) AC power of proper voltage and frequency is present at input terminals.

b) Either positive or negative terminal is connected to chassis ground.

c) The power supply is connected for constant voltage with local sensing. See schematic, dotted lines indicate jumpers connected for local sensing operation.

TROUBLE SHOOTING CHART

Symptom	Probable Cause	Remedy
1. Zero volts DC output	OUTPUT VOLTAGE control turned fully CCW	Check OUTPUT VOLTAGE control for proper setting & correct as necessary
	Short circuit across output of supply	Check load and load connections, correct as necessary
	Series regulator section open	Check Q6 through Q11 and R25-30 for open, replace as necessary
	Shorted CR7	Check CR7 for short, replace as necessary
	Current sensing resistor open	Check R25 for open, R6 for short
	Aux. rectifier CR1 open	Check CR1 for open, replace as necessary
	Open CR8, CR9, or R1	Check & replace as necessary
2. Unable to adjust output voltage	Damaged OUTPUT VOLTAGE control	Check R8 for short or open, replace as necessary

TROUBLE SHOOTING CHART

Symptom	Probable Cause	Remedy
3. High ripple at line frequency or twice line frequency & unregulated DC output	Series regulator transistor shorted	Check and replace as necessary; Q1, Q2, Q6 through Q11
	Defective main rectifier causes ripple at twice line frequency	Check for open and/or short CR2, CR3, CR4 & CR5
4. Same as 3, except intermittent	Foreign matter fallen into unit	Check for loose bench hardware & wire clippings that may have fallen through cover
5. High ripple at frequency other than line or twice line frequency	Oscillation due to defective component in filter network	Check for open C14, C2 & check for open and/or short in C11 & R2. Replace defective component
6. Large spikes at output	Capacitor C15 and, as applicable, C16 open	Replace C15 (and C16)

PERFORMANCE CHECKS

Check the ripple and regulation of the power supply using the test connection diagram shown in figure 12. Use suggested test equipment or equivalent to obtain accurate results. Refer to Specifications and Features for minimum performance standards.

Set the differential meter, DVM (John Fluke Model 891A or equivalent) to the selected power supply operating voltage. Check the power supply load regulation accuracy while switching from the load to no-load condition. Long load leads should be a twisted pair to minimize AC pick-up.

Use a Variac to vary the line voltage from 105-132 or 132-105 volts AC and check the power supply line regulation accuracy on the DVM differential meter.

Use a VTVM, Ballantine 320 or equivalent, to measure rms ripple voltage of the power supply DC output. Use oscilloscope to measure peak-to-peak ripple voltage of the power supply DC output.

ADJUSTMENT OF CALIBRATION CONTROL R13

Whenever Q6 through Q11, R6, R25 through R30, R9, R13, R21, or IC1 are replaced, and voltage and current indications do not reflect maximum ratings, adjust R13 as follows. The adjustment procedure requires that the power supply is removed from associated equipment, is at an ambient temperature of 25-30°C, and is stabilized and not operating.

1. Remove AC input power to the supply.

2. Break seal on wiper of R13 from resistor housing and turn to full CW position.

3. Operate power supply for constant voltage with local sensing connected as shown in figure 3, with no external load.

4.* Turn voltage adjust control until minimum rated output voltage is obtained.

5.* Apply load so that output current is 110% of 40°C rating for the unit.

6.* Using an oscilloscope, Tektronix 503 or equivalent, observe output voltage while adjusting R13 in CCW direction. Adjust R13 until output ripple begins to increase.

7.* Turn voltage adjust control until maximum rated output voltage is obtained.

8.* Increase load. Maximum attainable load current shall not exceed 130% of 40°C rating for the unit.

9.* After adjustment is completed, remove AC power input to the supply and use glyptol sealant to seal wiper of R13 to resistor housing.

10.* After sealing, check setting and repeat adjustment procedure if required.

* Perform alternate steps 4A through 9A for adjustment of R13 on models LCS-D-01 -- LCS-D-03.

4A. Turn voltage adjust control until rated output is obtained.

5A. Apply load so that output current is 110% of 40°C rating for the unit.

6A. Using an oscilloscope, Tektronix 503 or equivalent, observe unit output voltage while adjusting R13 in a CCW direction. Adjust R13 until output ripple increases sharply and oscilloscope pattern changes.

7A. Place a DC ammeter of appropriate scale across output terminals 4 and 6 of the supply. The meter indication shall be a maximum of 115% of 40°C rating for the unit.

8A. After adjustment is completed, remove AC input power to the supply and use glyptol sealant to seal wiper of R13 to resistor housing.

9A. After sealing, check setting and repeat adjustment procedure if required.

SERVICE

When additional instructions are required or repair service is desired, contact the nearest Lambda office where trained personnel and complete facilities are ready to assist you.

Please include the power supply model and serial number together with complete details of the problem. On receipt of this information Lambda will supply service data or advise shipping for factory repair service.

All repairs not covered by the warranty will be billed at cost and an estimate forwarded for approval before work is started.

PARTS ORDERING

Standard components and special components used in the Lambda power supply can be obtained from the factory. In case of emergency, critical spare parts are available through any Lambda office.

The following information must be included when ordering parts:

1. Model number and serial number of power supply and purchase date.

2. Lambda part number.

3. Description of part together with circuit designation.

4. If part is not an electronic part, or is not listed, provide a description, function, and location of the part.

PARTS LIST

The electrical parts located on Lambda models LCS-D-2 — LCS-D-48 and LCS-D-01 — LCS-D-03 are listed here. Parts common to a group of models are listed first. Unique parts of individual models within the group are listed separately, by model, immediately following the group common-parts listing. In addition there are separate listings of parts for the "J" and "V" options and LMOV and LHOV accessories.

COMMON PARTS
MODELS LCS-D-2 — LCS-D-6

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
C1	Cap., elect., 40mf -10+75%, 35 vdc	CBP-40-036
C2	Cap., mylar, 0.047 mf ±10%, 200 vdc	CGL-47-018
C3, C4	Not assigned	
C5	Cap., mylar, 0.1 mf ±10%, 200 vdc	CAM-10-012
C6, C7	Cap., elect., 60,000 mf -10+100%, 15 vdc	CBT-60-036
C9	Cap., mylar, 1 mf ±10%, 200 vdc	CGN-10-005
C10	Cap., mylar, 0.033 mf ±10%, 400 vdc	CGL-33-009
C11	Cap., mylar, 0.0068 mf ±10%, 200 vdc	CGK-68-001
C12, C13	Not assigned	
C14	Cap., elect., 3,600 mf -10+100%, 20 · `	CBS-36-044
C15, C16	Same as C5	
C17 thru C33	Not assigned	
C34	Cap., elect., 2,100 mf -10+100%, 35 vdc	CBS-21-043
CB1	Circuit breaker	FHC-40-000-2
CR1	Rectifier	FBL-00-030
CR2, CR3	Rectifier	FBL-00-083
CR4 thru CR7	Not assigned	
CR8	Same as CR1	
CR9	Not assigned	
CR10, CR11	Same as CR1	
CR12	Not assigned	
CR13	Same as CR1	
CR14 thru CR21	Not assigned	
CR22	Rectifier, zener divide	FBM-Z139
CR23, CR24	Rectifier	FBL-00-094
CR25 thru CR27	Not assigned	
IC1	Integrated circuit	FBT-00-031
Q1	Transistor, NPN	FBN-L113
Q2	Transistor, NPN	FBN-L144
Q3 thru Q5	Not assigned	
Q6 thru Q11	Transistor, NPN	FBN-36485

COMMON PARTS (Cont.)
MODELS LCS-D-2 — LCS-D-6 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
Q12 thru Q17	Not assigned	
Q18	Transistor, NPN	FBN-L110
R1	Res., film, 8,660 ohms ±1%, ¼ w	DCS-87-071
R2	Res., comp., 100 ohms ±10%, ¼ w	DCB-1011
R3, R4	Res., comp., 560 ohms ±10%, 1 w	DGB-5611
R5	Res., comp., 1,000 ohms ±10%, ¼ w	DCB-1021
R6	Res., comp., 47 ohms ±10%, ¼ w	DCB-4701
R7	Not assigned	
R9	Res., film, 10,000 ohms ±1%, ¼ w	DCT-10-047
R10	Res., comp., 36 megohms ±5%, ¼ w	DCB-3665
R11	Not assigned	
R12	Res., comp., 68,000 ohms ±10%, ¼ w	DCB-6831
R13	Res., var., cermet, 5,000 ohms ±10%, 1 w	DRS-50-010
R14	Not assigned	
R15		
R16	Res., comp., 33 ohms ±5%, ¼ w	DCB-3305
R17 thru R19, R22	Not assigned	
R23	Res., comp., 4,700 ohms ±10%, ¼ w	DCB-4721
R24	Not assigned	
R25 thru R27	Res., center tapped, ww, 0.2 ohm ±5%, 22 w	DFM-20-054
R28 thru R39, R41 thru R49	Not assigned	
R50	Res., ww, 0.208 ohm ±3%, 3 w	DFM-21-030
R51	Same as R5	
S1	Thermostat	FKA-155-020

UNIQUE PARTS
MODEL LCS-D-2

C8	Not assigned	
R8	Res., var., ww, 2,200 ohms ±5%, 2 w	DNS-22-056

UNIQUE PARTS (Cont.)

MODEL LCS-D-2 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
R20	Res., film, 1,470 ohms ±1%, ¼ w	DCS-15-056
R21	Res., film, 6,800 ohms ±2%, ¼ w	DCS-68-032
R40	Not assigned	
T1	Transformer	ABA-LCSD-2

MODEL LCS-D-5-OV

C8	Cap., elect., 10 mf ±20%, 10 vdc	CBP-10-027
CR28	Rectifier, zener diode	FBM-Z140
R8	Res., var., ww, 4,500 ohms ±5%, 2 w	DNS-45-050
R20	Res., film, 3,830 ohms ±1%, ¼ w	DCS-38-060
R21	Res., film, 15,000 ohms ±5%, ¼ w	DCT-15-062
R40	Res., comp., 100 ohms ±10%, ¼ w	DCB-1011
SCR1	Rectifier, silicon controlled	FBP-00-036
T1	Transformer	ABA-LCSD-5

MODEL LCS-D-6

C8	Not assigned	
R8	Res., var., ww, 4,500 ohms ±5%, 2 w	DNS-45-050
R20	Res., film, 3,830 ohms ±1%, ¼ w	DCS-38-060
R21	Res., film, 15,000 ohms ±5%, ¼ w	DCT-15-062
R40	Not assigned	
T1	Transformer	ABA-LCSD-6

COMMON PARTS

MODELS LCS-D-12 and LCS-D-15

C1	Cap., elect., 40 mf -10+75%, 33 vdc	CBP-40-036
C2	Cap., mylar, 0.047 mf ±10%, 200 vdc	CGL-47-018
C3, C4	Not assigned	
C5	Cap., mylar, 0.1 mf ±10%, 200 vdc	CAM-10-012
C6, C7	Cap., elect., 22,000 mf -10+100%, 40 vdc	CBT-22-021
C8	Not Assigned	
C9	Cap., mylar, 1 mf ±10%, 200 vdc	CGN-10-005
C10	Cap., mylar, 0.033 mf ±10%, 400 vdc	CGL-33-009
C11	Cap., mylar, 0.0068 mf ±10%, 200 vdc	CGK-68-001
C12, C13	Not assigned	
C14	Cap., elect., 2,100 mf -10+100%, 35 vdc	CBS-21-043
C15	Same as C5	
CR1	Rectifier	FBL-00-030
CR2 thru CR5	Rectifier	FBL-00-083
CR6, CR7	Not assigned	
CR8	Same as CR1	
CR9	Not assigned	

COMMON PARTS (Cont.)

MODELS LCS-D-12 and LCS-D-15 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
CR10, CR11	Same as CR1	
CR12	Not assigned	
CR13	Same as CR1	
CR14 thru CR21	Not assigned	
CR22	Rectifier, zener diode	FBM-Z139
IC1	Integrated circuit	FBT-00-031
Q1	Transistor, NPN	FBN-L109
Q2	Transistor, NPN	FBN-36485
Q3 thru Q5	Not assigned	
Q6 thru Q11	Same as Q2	
R1	Res., film, 8,660 ohms ±1%, ¼ w	DCS-87-071
R2	Res., comp., 100 ohms ±10%, ¼ w	DCB-1011
R3, R4	Res., comp., 1,800 ohms ±10%, 1 w	DGB-1821
R5	Res., comp., 1,000 ohms ±10%, ¼ w	DCB-1021
R6	Res., comp., 47 ohms ±10%, ¼ w	DCB-4701
R7	Not assigned	
R8	Res., var., ww, 13,000 ohms ±5%, 2 w	DNT-13-032
R9	Res., film, 10,000 ohms ±1%, ¼ w	DCT-10-047
R10	Res., comp., 36 megohms ±5%, ¼ w	DCB-3665
R11	Not assigned	
R12	Res., comp., 68,000 ohms ±10, ¼ w	DCB-6831
R13	Res., var., cermet, 5,000 ohms ±10%, 1 w	DRS-50-010
R14, R15	Not assigned	
R16	Res., comp., 33 ohms ±5%, ¼ w	DCB-3305
R17 thru R19	Not assigned	
R20	Res., film, 9,090 ohms ±1%, ¼ w	DCS-91-054
R21	Res., film, 50,000 ohms ±1%, ¼ w	DCT-50-054
R22	Not assigned	
R23	Res., comp., 4,700 ohms ±10%, ¼ w	DCB-4721
R24	Not assigned	
R25 thru R30	Res., ww, 0.22 ohm ±5%, 5 w	DFM-22-045
S1	Thermostat	FKA-155-020

UNIQUE PARTS

MODEL LCS-D-12

T1	Transformer	ABA-LCSD-12

MODEL LCS-D-15

T1	Transformer	ABA-LCSD-15

COMMON PARTS
MODELS LCS-D-20 — LCS-D-48

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
C1	Cap., elect., 40 mf -10+75%, 33 vdc	CBP-40-036
C2	Cap., mylar, 0.047 mf ±10%, 200 vdc	CGL-47-018
C3, C4	Not assigned	
C5	Cap., mylar, 0.1 mf ±10%, 200 vdc	CAM-10-012
C8	Not assigned	
C9	Cap., mylar, 1 mf ±10%, 200 vdc	CGN-10-005
C10	Cap., mylar, 0.033 mf ±10%, 400 vdc	CGL-33-009
C11	Cap., mylar, 0.0068 mf ±10%, 200 vdc	CGK-68-001
C12, C13	Not assigned	
C15	Same as C5	
CR1	Rectifier	FBL-00-030
CR2 thru CR5	Rectifier	FBL-00-083
CR6, CR7, CR9	Not assigned	
CR10, CR11	Same as CR1	
CR12	Not assigned	
CR13	Same as CR1	
CR14 thru CR21	Not assigned	
CR22	Rectifier, zener diode	FBM-Z139
IC1	Integrated circuit	FBT-00-031
Q3 thru Q5	Not assigned	
R1	Res., film, 8,660 ohms ±1%, ¼ w	DCS-87-071
R2	Res., comp., 100 ohms ±10%, ¼ w	DCB-1011
R5	Res., comp., 1,000 ohms ±10%, ¼ w	DCB-1021
R6	Res., comp., 47 ohms ±10%, ¼ w	DCB-4701
R7	Not assigned	
R9	Res., film, 10,000 ohms ±1%, ¼ w	DCT-10-047
R10	Res., comp., 36 megohms ±5%, ¼ w	DCB-3665
R11	Not assigned	
R12	Res., comp., 68,000 ohms ±10%, ¼ w	DCB-6831
R13	Res., var., cermet, 5,000 ohms ±10%, 1 w	DRS-50-010
R14, R15	Not assigned	
R16	Res., comp., 33 ohms ±5%, ¼ w	DCB-3305
R17 thru R19, R22	Not assigned	
R23	Res., comp., 4,700 ohms ±10%, ¼ w	DCB-4721
R24	Not assigned	
S1	Thermostat	FKA-155-020

UNIQUE PARTS
MODEL LCS-D-20

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
C6, C7	Cap., elect., 13,000 mf -10+100%, 60 vdc	CBT-13-023
C14	Cap., elect., 1,100 mf -10+100%, 60 vdc	CBS-11-042
CR8	Rectifier	FBL-00-030
Q1	Transistor, NPN	FBN-L109
Q2, Q6 thru Q11	Transistor, NPN	FBN-36220
R3	Res., ww, 2,000 ohms ±3%, 3 w	DFS-20-032
R4	Res., comp., 3,300 ohms ±5%, 1 w	DGB-3325
R8	Res., var., ww, 15,000 ohms ±5%, 2 w	DNT-15-063
R20	Res., film, 15,000 ohms ±5%, ¼ w	DCT-15-062
R21	Res., film, 66,500 ohms ±1%, ¼ w	DCT-67-074
R25 thru R30	Res., ww, 0.39 ohm ±5%, 5 w	DFM-39-046
T1	Transformer	ABA-LCSD-20

MODEL LCS-D-24

C6, C7	Cap., elect., 13,000 mf -10+100%, 60 vdc	CBT-13-023
C14	Cap., elect., 1,100 mf -10+100%, 60 vdc	CBS-11-042
CR8	Rectifier	FBL-00-030
Q1	Transistor, NPN	FBN-L109
Q2, Q6 thru Q11	Transistor, NPN	FBN-36220
R3	Res., ww, 2,000 ohms ±3%, 3 w	DFS-20-032
R4	Res., comp., 3,300 ohms ±5%, 1 w	DGB-3325
R8	Res., var., ww, 15,000 ohms ±5%, 2 w	DNT-15-063
R20	Res., film, 20,000 ohms ±1%, ¼ w	DCT-20-053
R21	Res., film, 100,000 ohms ±1%, ¼ w	DCV-10-027
R25 thru R30	Res., ww, 0.39 ohm ±5%, 5 w	DFM-39-046
T1	Transformer	ABA-LCSD-24

MODEL LCS-D-28

C6, C7	Cap., elect., 13,000 mf -10+100%, 60 vdc	CBT-13-023
C14	Cap., elect., 1,100 mf -10+100%, 60 vdc	CBS-11-042
CR8	Rectifier	FBL-00-030
Q1	Transistor, NPN	FBN-L109
Q2, Q6 thru Q11	Transistor, NPN	FBN-36220

UNIQUE PARTS (Cont.)

MODEL LCS-D-28 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
R3	Res., ww, 2,000 ohms ±3%, 3 w	DFS-20-032
R4	Res., comp., 3,300 ohms ±5%, 1 w	DGB-3325
R8	Res., var., ww, 15,000 ohms ±5%, 2 w	DNT-15-063
R20	Res., film, 20,000 ohms ±1%, ¼ w	DCT-20-053
R21	Res., film, 120,000 ohms ±1%, ¼ w	DCV-12-029
R25 thru R30	Res., ww, 0.39 ohm ±5%, 5 w	DFM-39-046
T1	Transformer	ABA-LCSD-28

MODEL LCS-D-48

C6, C7	Cap., elect., 4,000 mf -10+100%, 100 vdc	CBS-40-053
C14	Cap., elect., 520 mf -10+100%, 100 vdc	CBR-52-025
CR8	Rectifier	FBL-00-036
Q1	Transistor, NPN	FBN-L115
Q2, Q6 thru Q11	Transistor, NPN	FBN-35902
R3	Res., ww, 5,600 ohms ±3%, 3 w	DFS-56-053
R4	Res., ww, 9,000 ohms ±3%, 3 w	DFS-90-071
R8	Res., var., ww, 23,000 ohms ±5%, 2 w	DNT-23-067
R20	Res., film, 40,200 ohms ±1%, ¼ w	DCT-40-058
R21	Res., film, 120,000 ohms ±1%, ¼ w	DCV-12-029
R25 thru R30	Res., ww, 0.5 ohm ±5%, 3 w	DFM-50-073
T1	Transformer	ABA-LCSD-48

COMMON PARTS

MODELS LCS-D-01 — LCS-D-03

C1	Cap., elect., 40 mf -10+75%, 33 vdc	CBP-40-036
C2	Cap., mylar, 0.047 mf ±10%, 200 vdc	CGL-47-018
C3, C4	Not assigned	
C5	Cap., mylar, 0.1 mf ±10%, 200 vdc	CAM-10-012
C7, C8	Not assigned	
C9	Cap., mylar, 1 mf ±10%, 200 vdc	CGN-10-005
C10	Cap., mylar, 0.033 mf ±10%, 400 vdc	CGL-33-009
C11	Cap., mylar, 0.0068 mf ±10%, 200 vdc	CGK-68-001
C12, C13	Not assigned	
C15, C16	Same as C5	

COMMON PARTS (Cont.)

MODELS LCS-D-01 — LCS-D-03 (Cont.)

CIRC DESIG	DESCRIPTION	LAMBDA NO.
C17 thru C33	Not assigned	
CR1	Rectifier	FBL-00-030
CR2, CR3	Rectifier	FBL-00-054
CR4 thru CR6	Not assigned	
CR7	Same as CR2	
CR8 thru CR11	Same as CR1	
CR12	Not assigned	
CR13	Same as CR1	
CR14, CR15	Not assigned	
CR16	Same as CR2	
CR17, CR20, CR21	Not assigned	
CR22	Rectifier, zener diode	FBM-Z139
IC1	Integrated circuit	FBT-00-031
Q3, Q4, Q12 thru Q17	Not assigned	
R1	Res., film, 8,660 ohms ±1%, ¼ w	DCS-87-071
R2	Res., comp., 100 ohms ±10%, ¼ w	DCB-1011
R5	Res., comp., 1,000 ohms ±10%, ¼ w	DCB-1021
R6	Res., film, 249 ohms ±1%, ¼ w	DCR-25-034
R7	Not assigned	
R9	Res., film, 10,000 ohms ±1%, ¼ w	DCT-10-047
R10	Res., comp., 36 megohms ±5%, ¼ w	DCB-3665
R11	Not assigned	
R12	Res., comp., 68,000 ohms ±10%, ¼ w	DCB-6831
R13	Res., var., cermet, 100 ohms ±20%, 1 w	DRR-10-010
R14, R15	Not assigned	
R16	Res., comp., 470 ohms ±10%, ¼ w	DCB-4711
R20 thru R22, R24, R31 thru R38, R40 thru R49	Not assigned	
S1	Thermostat	FKA-155-020

UNIQUE PARTS

MODEL LCS-D-01

C6	Cap., elect., 60,000 mf -10+100%, 15 vdc	CBT-60-036

UNIQUE PARTS (Cont.)

MODEL LCS-D-01 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
C14	Cap., elect., 3,600 mf -10+100%, 20 vdc	CBS-36-044
C34	Cap., elect., 2,100 mf -10+100%, 35 vdc	CBS-21-043
CR18, CR19	Not assigned	
CR23, CR24	Rectifier	FBL-00-094
Q1	Transistor, NPN	FBN-L109
Q2	Transistor, NPN	FBN-36485
Q5	Not assigned	
Q6 thru Q11	Same as Q2	
Q18	Transistor, NPN	FBN-L110
R3	Res., comp., 1,000 ohms ±10%, 1 w	DGB-1021
R4	Res., comp., 560 ohms ±10%, 1 w	DGB-5611
R8	Res., var., ww, 9,000 ohms ±5%, 2 w	DNS-90-058
R17 thru R19, R23	Not assigned	
R25 thru R30	Res., ww, 0.39 ohm ±5%, 5 w	DFM-39-046
R39	Res., film, 100,000 ohms ±1%, ¼ w	DCV-10-027
R50	Res., ww, 0.56 ohm ±5%, 3 w	DFM-56-042
R51	Res., comp., 1,000 ohms ±10%, ¼ w	DCB-1021
T1	Transformer	ABA-LCSD-01

MODEL LCS-D-02

C6	Cap., elect., 22,000 mf -10+100%, 40 vdc	CBT-22-021
C14	Cap., elect., 2,100 mf -10+100%, 35 vdc	CBS-21-043
CR18, CR19	Rectifier	FBL-00-030
Q1	Transistor, NPN	FBN-L109
Q2	Transistor, NPN	FBN-36485
Q5	Same as Q1	
Q6 thru Q11	Same as Q2	
R3	Res., comp., 3,300 ohms ±5%, 1 w	DGB-3325
R4	Not assigned	
R8	Res., var., ww, 23,000 ohms ±5%, 2 w	DNT-23-067
R17	Same as R3	
R18	Res., comp., 820 ohms ±10%, ¼ w	DCB-8211
R19	Res., comp., 220 ohms ±10%, ¼ w	DCB-2211
R23	Not assigned	
R25 thru R30	Res., ww, 0.75 ohm ±5%, 5 w	DFM-75-044
R39	Res., film, 100,000 ohms ±1%, ¼ w	DCV-10-027
T1	Transformer	ABA-LCSD-02

UNIQUE PARTS (Cont.)

MODEL LCS-D-03

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
C6	Cap., elect., 13,000 mf -10+100%, 60 vdc	CBT-13-023
C14	Cap., elect., 1,100 mf -10+100%, 60 vdc	CBS-11-042
CR18, CR19	Rectifier	FBL-00-030
Q1	Transistor, NPN	FBN-L115
Q2	Transistor, NPN	FBN-36220
Q5	Transistor, NPN	FBN-L109
Q6 thru Q11	Same as Q2	
R3	Res., comp., 10,000 ohms ±10%, 1 w	DGB-1031
R4	Not assigned	
R8	Res., var., cermet, 40,000 ohms ±10%, 2 w	DRT-40-047
R17	Same as R3	
R18	Res., comp., 820 ohms ±10%, ¼ w	DCB-8211
R19	Res., comp., 220 ohms ±10%, ¼ w	DCB-2211
R23	Res., film, 100,000 ohms ±1%, ¼ w	DCV-10-027
R25 thru R30	Res., ww, 1.5 ohm ±3%, 5 w	DFN-15-059
R39	Res., comp., 220,000 ohms ±10%, ¼ w	DCB-2241
T1	Transformer	ABA-LCSD-03

PARTS FOR "J" OPTION

On all LCS-D models with suffix "J", transformer T1 changes. For transformer T1 used on these models, see standard LCS-D model parts list for standard transformer part no. and add suffix "J" to the part no.

PARTS FOR "V" OPTION

On all LCS-D models with suffix "V", capacitor C10 and transformer T1 change. Part no. change for C10 is listed here. For transformer T1 used on these models, see standard LCS-D model parts list for the standard transformer part no. and add suffix "G" to the part no.

ALL MODELS

C10	Cap., paper, 0.01 mf ±10%, 1000 vdc	CAL-10-021

PARTS FOR OVERVOLTAGE PROTECTOR ACCESSORY MODELS

LMOV-1, LMOV-2, LMOV-3, LHOV-4, LHOV-5

COMMON PARTS

C1	Cap., mylar, 0.01 mf ±20%, 80 vdc	CGL-10-008
Q1	Transistor, NPN	FBN-L102
R3	Res., film, 200 ohms ±5%, ½ w	DCR-20-010

PARTS FOR OVERVOLTAGE PROTECTOR ACCESSORY MODELS LMOV-1, LMOV-2, LMOV-3, LHOV-4, LHOV-5 (Cont.)

COMMON PARTS (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
R4	Res., thermistor 425 ohms ±5%, 1¼ w	DKR-43-004
R5, R6	Res., comp., 1,200 ohms ±10%, ½ w	DEB-1221
R8	Res., comp., 15,000 ohms ±10%, ½ w	DEB-1531
R10	Same as R5	
SCR1	Rectifier, silicon con controlled	FBP-00-009

UNIQUE PARTS

MODEL LMOV-1

Q2	Transistor, PNP	FBN-L103
R1	Res., var., ww or cermet, 2,000 ohms ±10%, ¼ w	DNS-20-034
R2	Res., film, 560 ohms ±2%, ½ w	DCR-56-002
R7	Res., comp., 33 ohms ±5%, ¼ w	DCB-3305
R9	Not assigned	

MODEL LMOV-2

Q2	Transistor, PNP	FBN-L103
R1	Res., var., ww or cermet, 5,000 ohms ±10%, ¾ w	DNS-50-036
R2	Res., film, 1,470 ohms ±1%, ½ w	DCS-15-031
R7	Res., comp., 33 ohms ±5%, ¼ w	DCB-3305
R9	Not assigned	

MODEL LMOV-3

Q2	Transistor, PNP	FBN-L114
R1	Res., var., ww or cermet, 20,000 ohms ±10%, ¾ w	DNT-20-010
R2	Res., film, 4,700 ohms ±2%, ½ w	DCS-47-028
R7	Res., comp., 39 ohms ±5%, ¼ w	DCB-3905
R9	Res., comp., 22 ohms ±10%, ½ w	DEB-2201

MODEL LHOV-4

Q2	Transistor, PNP	FBN-L114
R1	Res., var., ww or cermet, 10,000 ohms ±10%, ¾ w	DNT-10-045
R2	Res., film, 560 ohms ±2%, ½ w	DCR-56-002
R7	Res., comp., 33 ohms ±5%, ¼ w	DCB-3305
R9	Res., comp., 22 ohms ±10%, ½ w	DEB-2201

MODEL LHOV-5

Q2	Transistor, PNP	FBN-L114
R1	Res., var., ww or cermet, 20,000 ohms ±10%, ¾ w	DNT-20-010
R2	Res., film, 560 ohms ±2%, ½ w	DCR-56-002

PARTS FOR OVERVOLTAGE PROTECTOR ACCESSORY MODELS LMOV-1, LMOV-2, LMOV-3, LHOV-4, LHOV-5 (Cont.)

UNIQUE PARTS (Cont.)

MODEL LHOV-5 (Cont.)

CIRC. DESIG.	DESCRIPTION	LAMBDA NO.
R7	Res., comp., 33 ohms ±5%, ¼ w	DCB-3305
R9	Res., comp., 22 ohms ±10%, ½ w	DEB-2201

PARTS FOR METERED AND NON-METERED PANEL ACCESSORIES MODELS MP-50, P-50

C1, C2	Cap., tant., 2.5 mf -15 +75%, 100 vdc (ALL)	CBN-25-010
DS1	Pilot light assembly (ALL)	HRD-00-007
F1	Fuse, 10A, 3AB, SLO-BLO (ALL)	FFG-10-000
M1*	Voltmeter, 0-5 vdc (LCS-D-2)	EBN-50-003
M1*	Voltmeter, 0-8 vdc (LCS-D-5-OV, LCS-D-6, LCS-D-01)	EBN-80-005
M1*	Voltmeter, 0-15 vdc (LCS-D-12)	EBP-15-017
M1*	Voltmeter, 0-20 vdc (LCS-D-15, LCS-D-02)	EBP-20-014
M1*	Voltmeter, 0-25 vdc (LCS-D-20)	EBP-25-018
M1*	Voltmeter, 0-40 vdc (LCS-D-24, LCS-D-28, LCS-D-03)	EBP-40-013
M1*	Voltmeter, 0-60 vdc (LCS-D-48)	EBP-60-015
M2*	Ammeter, 0-50.adc (LCS-D-2 thru LCS-D-6)	EDP-50-017
M2*	Ammeter, 0-30 adc (LCS-D-12)	EDP-30-016
M2*	Ammeter, 0-20 adc (LCS-D-15 thru LCS-D-24, LCS-D-01)	EDP-20-015
M2*	Ammeter, 0-15 adc (LCS-D-28)	EDP-15-014
M2*	Ammeter, 0-10 adc (LCS-D-48, LCS-D-02)	EDP-10-013
M2*	Ammeter, 0-6 adc (LCS-D-03)	EDN-60-018
R1	Res., var., ww, 2,200 ohms ±5%, 2 w (LCS-D-2)	DNS-22-053
R1	Res., var., ww, 4,500 ohms ±5%, 2 w (LCS-D-5OV, LCS-D-6)	DNS-45-059
R1	Res., var., ww, 9,000 ohms ±5%, 2 w (LCS-D-01)	DNS-90-051

PARTS FOR METERED AND NON-METERED PANEL ACCESSORIES (Cont.) MODELS MP-50, P-50 (Cont.)

CIRC. DESIGN	DESCRIPTION	LAMBDA NO.
R1	Res., var., ww, 13,000 ohms ±5%, 2 w (LCS-D-12, LCS-D-15)	DNT-13-031
R1	Res., var., ww, 15,000 ohms ±5%, 2 w (LCS-D-20 thru LCS-D-28)	DNT-15-068
R1	Res., var., ww, 23,000 ohms ±5%, 2 w (LCS-D-48, LCS-D-02)	DNT-23-069
R1	Res., var., cermet, 40,000 ohms ±10%, 2 w (LCS-D-03)	DRT-40-040
R51*	Res., meter shunt, 50A, 50mV (LCS-D-2 thru LCS-D-6)	ESP-50-002

PARTS FOR METERED AND NON-METERED PANEL ACCESSORIES (Cont.) MODELS MP-50, P-50 (Cont.)

CIRC. DESIGN	DESCRIPTION	LAMBDA NO.
R51*	Res., meter shunt, 30A, 50mV (LCS-D-12)	ESP-30-001
S1	Switch, SPST (ALL)	FDA-11-040
XF1	Fuseholder (ALL)	HRK-00-007

*Only used on MP-50

PARTS FOR METERED AND NON-METERED PANEL ACCESSORIES WITH "V" OPTION

On all MP-50 and P-50 panels with suffix "V", fuse F1 changes and a resistor is added in series with DS1. Part Nos. For F1 and DS1 Res. are listed below

F1	Fuse 5A, 3AB, SLO-BLO	FFG-05-000
Res. (DS1)	Res., comp., 120,000 ±10%, ½ w	DEB-1241

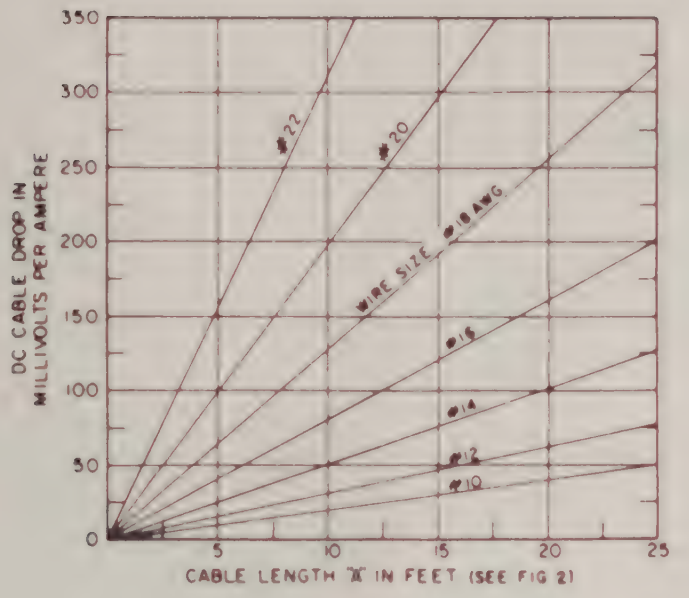


Figure 1. Cable Connection Chart

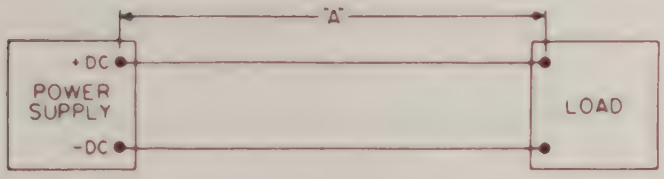
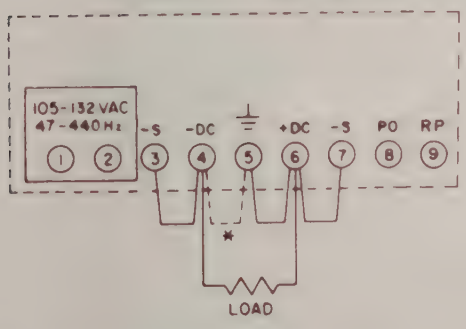


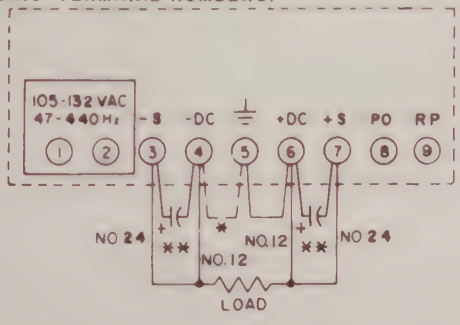
Figure 2. Cable Length "A" in Feet

NOTE:
OUTPUT TERMINAL CONFIGURATION SHOWN IN THE FOLLOWING FIGURES APPLIES TO MODELS LCS-D-12 THRU LCS-D-48 AND LCS-D-01 THRU LCS-D-03, BUT IS EQUALLY APPLICABLE TO MODEL LCS-D-2 THRU LCS-D-6 BY SUBSTITUTING THE CORRESPONDING TERMINAL NUMBERS.



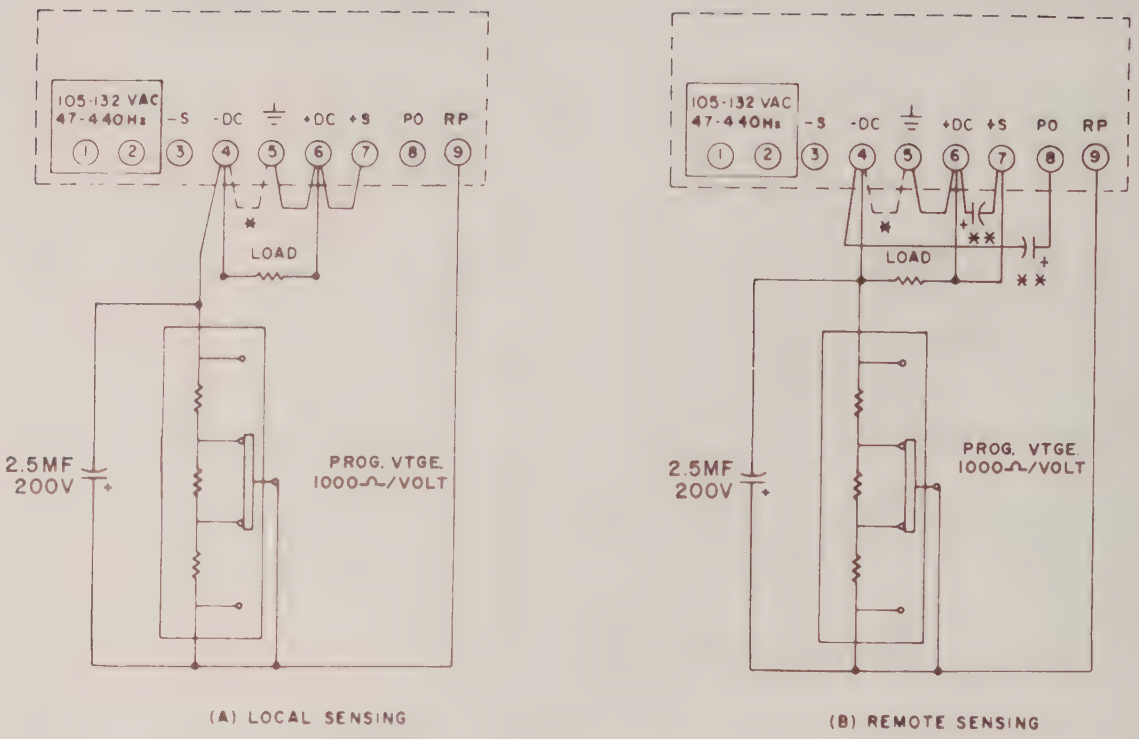
NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5

Figure 3. Local Sensing Connection.



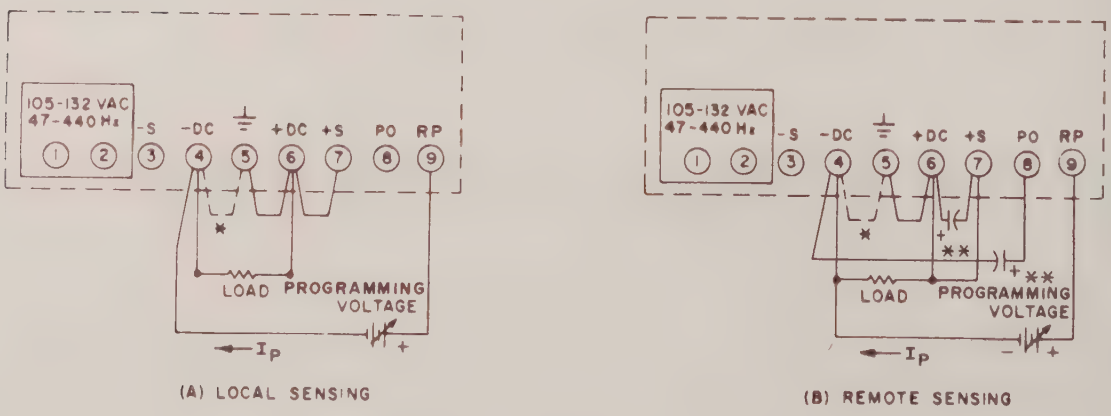
NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5
** A 2.5 MF, ELECT., CAP. MAY BE REQUIRED.

Figure 4. Remote Sensing Connection.



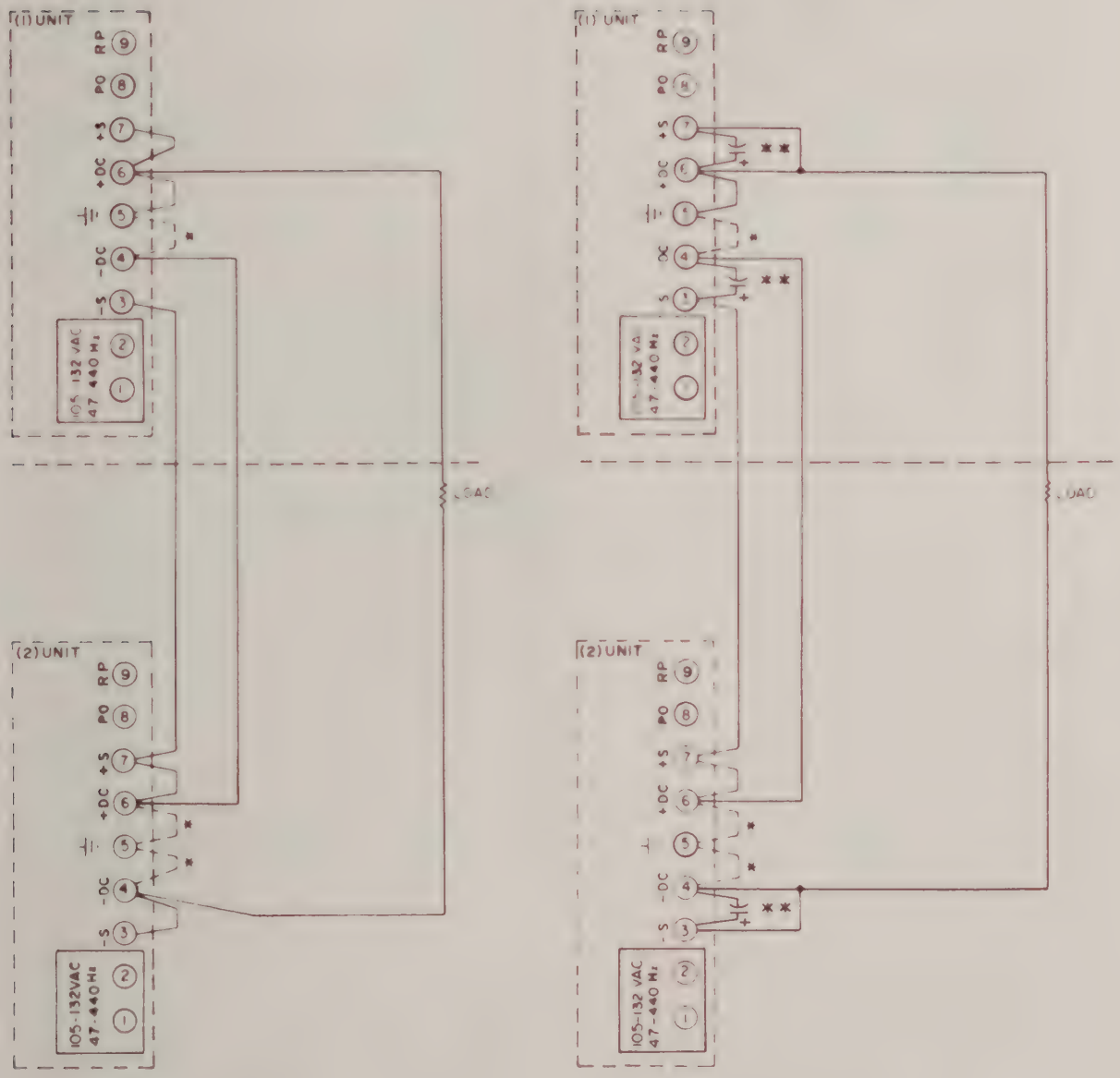
NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5
** A 2.5 MF, ELECT., CAP. MAY BE REQUIRED.

Figure 5. Programmed Voltage, With External Resistor



NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5
** A 2.5 MF, ELECT., CAP. MAY BE REQUIRED.

Figure 6. Programmed Voltage, With External Programming Voltage Source



(A) LOCAL SENSING

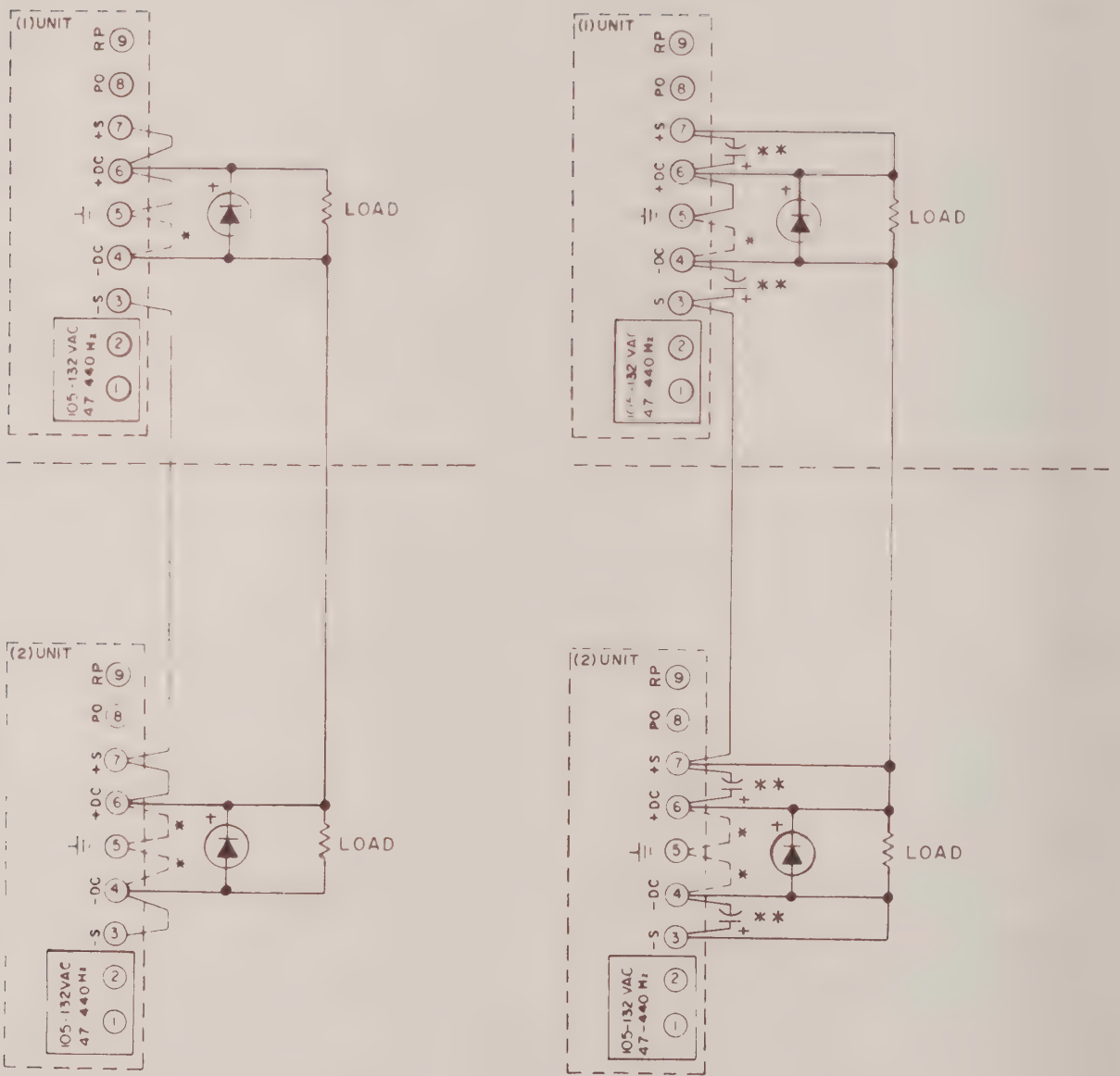
(B) REMOTE SENSING

NOTE

* MAKE ONLY ONE GROUND CONNECTION FOR THE SERIES COMBINATION, TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 5 AND 6 ON (1) UNIT AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE

** A 2.5 MF, ELECT., CAP. MAY BE REQUIRED.

Figure 7. Series Connection, Common Load. (LCS-D-01 through LCS-D-03 Only)



(A) LOCAL SENSING

(B) REMOTE SENSING

NOTE

* MAKE ONLY ONE GROUND CONNECTION FOR THE SERIES COMBINATION TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 5 AND 6 ON (1) UNIT AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE.

† DIODES NOT REQUIRED FOR MODELS LCS-D-01 THRU LCS-D-03.

** A 2.5 MF, ELECT., CAP. MAY BE REQUIRED.

Figure 8. Series Connection, Dual Load.

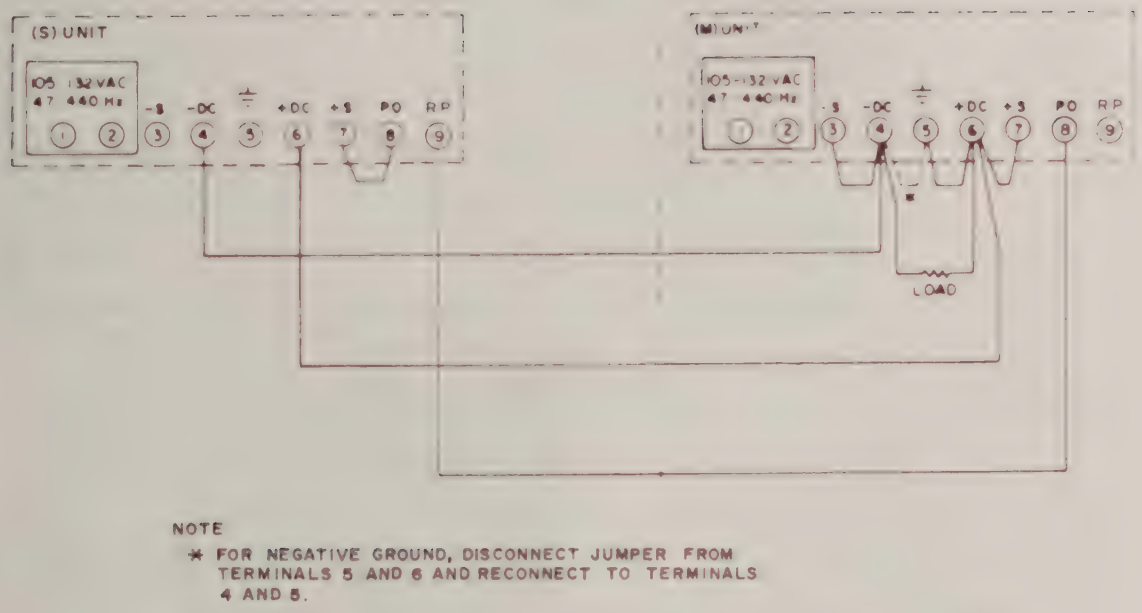


Figure 9. Parallel Connection, Local Sensing. (LCS-D-01 through LCS-D-03 Only)

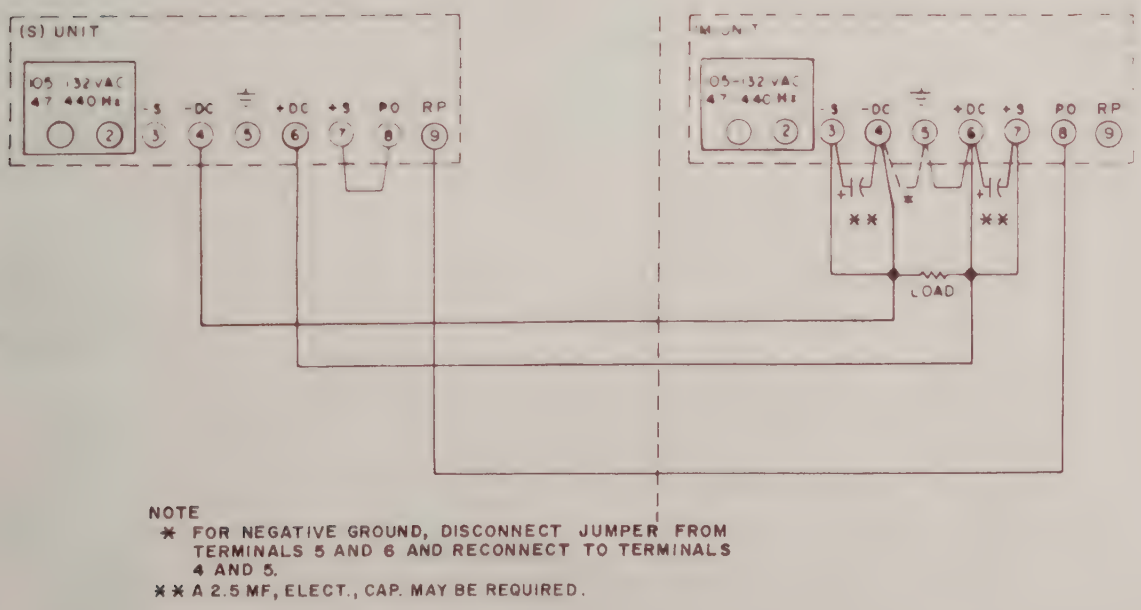
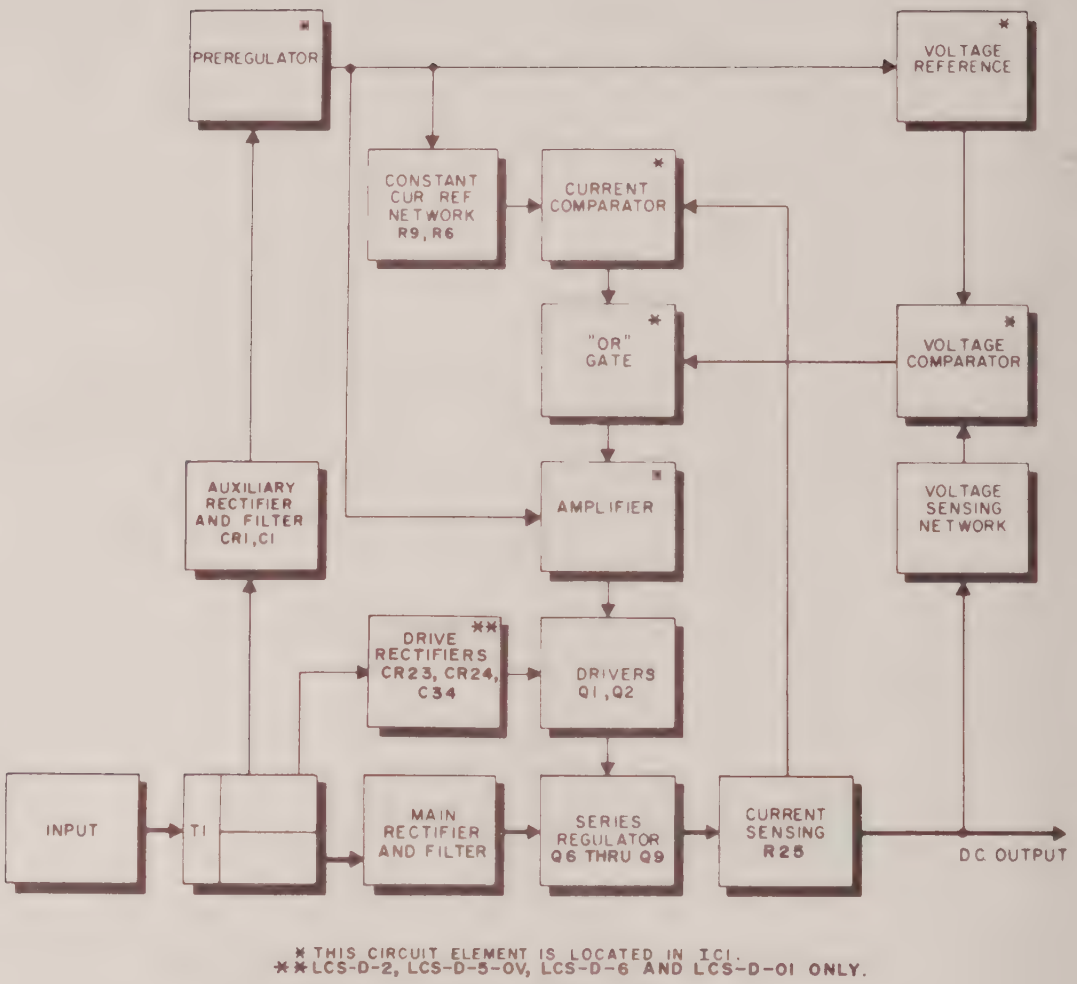
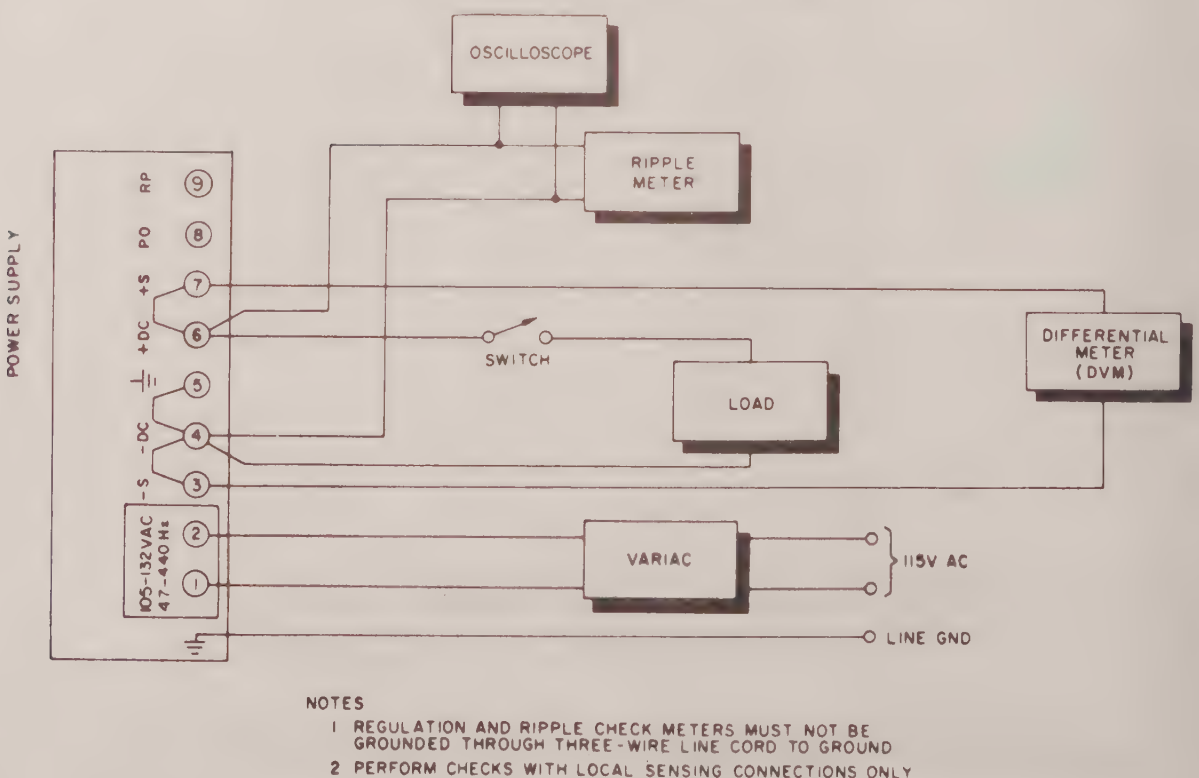


Figure 10. Parallel Connection, Remote Sensing. (LCS-D-01 through LCS-D-03 Only)



* THIS CIRCUIT ELEMENT IS LOCATED IN IC1.
** LCS-D-2, LCS-D-5-0V, LCS-D-6 AND LCS-D-01 ONLY.

Figure 11. Typical Block Diagram.



NOTES

1 REGULATION AND RIPPLE CHECK METERS MUST NOT BE GROUNDED THROUGH THREE-WIRE LINE CORD TO GROUND

2 PERFORM CHECKS WITH LOCAL SENSING CONNECTIONS ONLY

Figure 12. Test Connections For Constant Voltage Performance Checks.

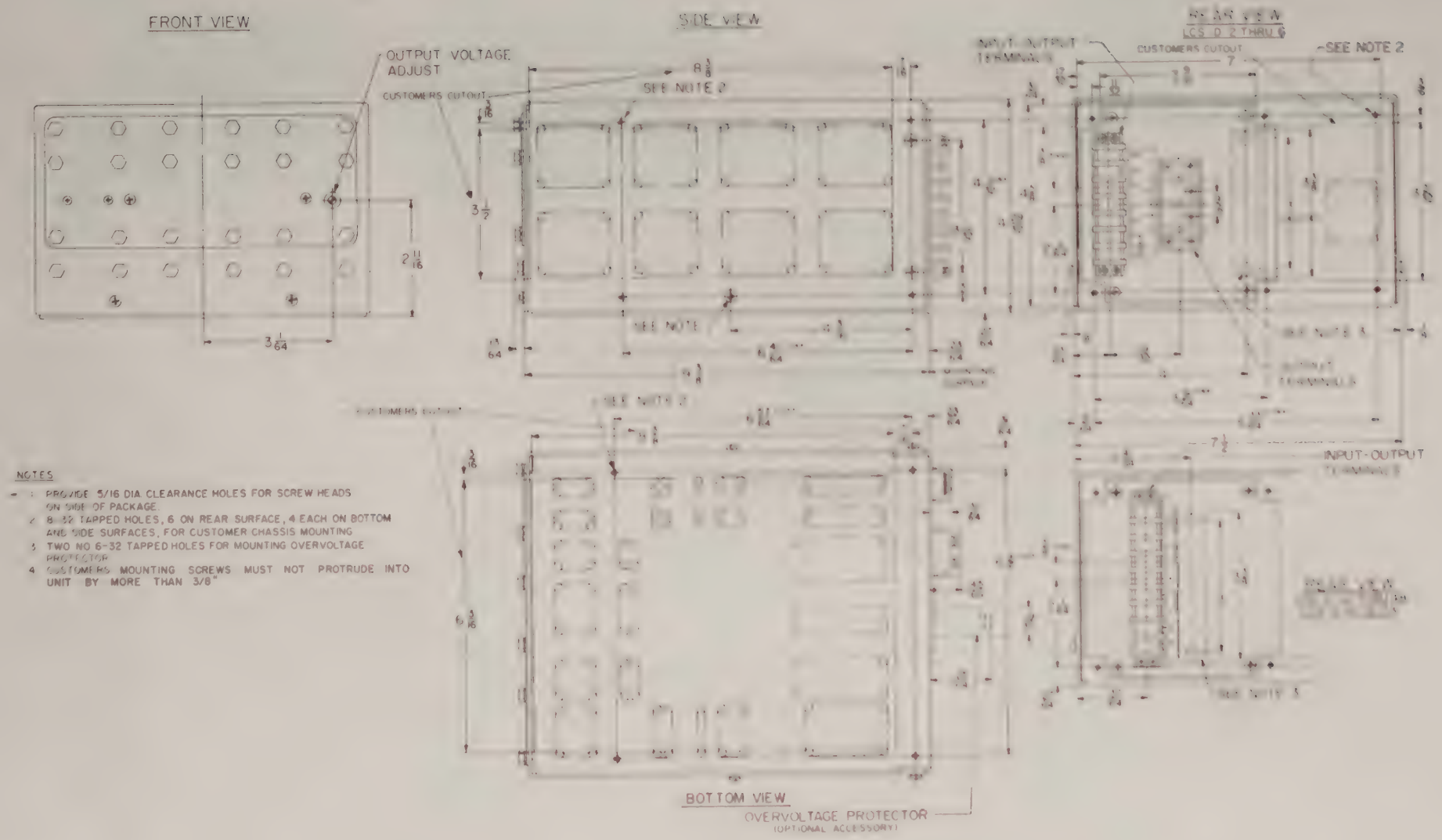
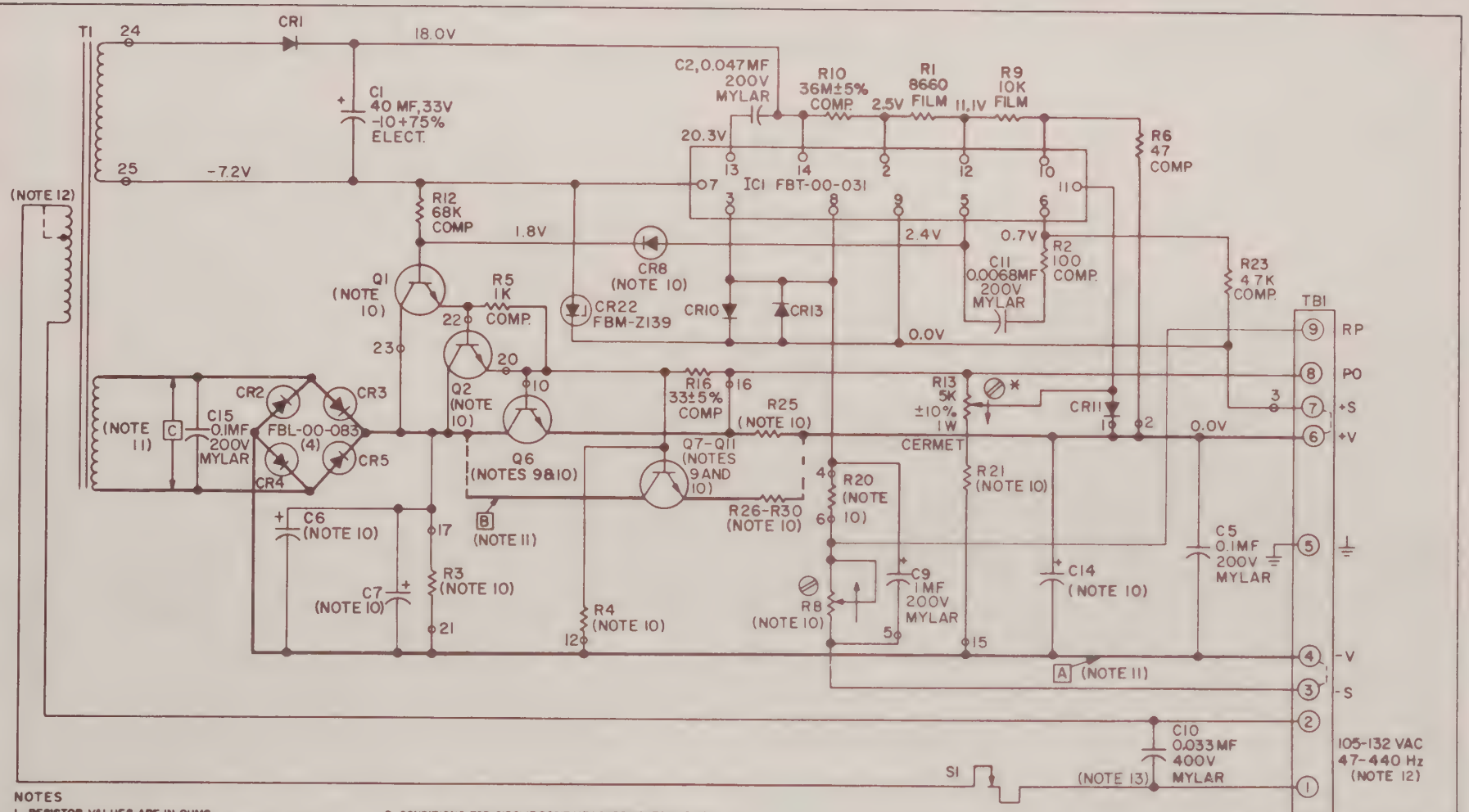

FRONT VIEW
SIDE VIEW
REAR VIEW
OUTPUT VOLTAGE ADJUST
CUSTOMERS CUTOUT
SEE NOTE 2
INPUT-OUTPUT TERMINALS
INPUT-OUTPUT
NOTES
1 PROVIDE 5/16 DIA CLEARANCE HOLES FOR SCREW HEADS ON SIDE OF PACKAGE.
2 8-32 TAPPED HOLES, 6 ON REAR SURFACE, 4 EACH ON BOTTOM AND SIDE SURFACES, FOR CUSTOMER CHASSIS MOUNTING
3 TWO NO 6-32 TAPPED HOLES FOR MOUNTING OVERVOLTAGE PROTECTOR
4 CUSTOMERS MOUNTING SCREWS MUST NOT PROTRUDE INTO UNIT BY MORE THAN 3/8"
BOTTOM VIEW
OVERVOLTAGE PROTECTOR
(OPTIONAL ACCESSORY)

Figure 13. Outline Drawing.



NOTES

1. RESISTOR VALUES ARE IN OHMS.
2. RESISTOR WATTAGE 1/4 WATT; RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED
3. RESISTOR TOLERANCES: COMP. ±10%; WIREWOUND ±2% FILM ±1%; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES ELECTROLYTIC -10%, +100%; MYLAR ±10%; CERAMIC 10%; UNLESS OTHERWISE NOTED.
5. SYMBOLS:
   - INDICATES CLOCKWISE ROTATION OF SHAFT.
   - INDICATES CONNECTION TO CHASSIS
   - INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   - SEE INSTRUCTION MANUAL.
   - LAMBDA PT #FBL-00-030, USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
   - INDICATES TERMINAL ON PRINTED WIRING BOARD.
6. DESIGNATION IS LAMBDA PART NUMBER.
7. DERATE CURRENT 10% FOR 47-53Hz, FOR 63-440Hz CONSULT FACTORY.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT: 115 VAC, 60Hz, NOM. RATED VOLTAGE NO LOAD. INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED; +S AND +V SHORTED, -S AND -V SHORTED
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. SEE TABLE I FOR COMPONENT VALUES
11. SEE TABLE I FOR VOLTAGE VALUES
12. ON UNITS WITH "V" OPTION, T1 HAS TAPPED PRIMARY. "V" OPTION UNITS CAN BE WIRED FOR 187-242V INPUT (USING TAP) OR FOR 205-265V INPUT (USING ENTIRE PRIMARY).
13. ON UNITS WITH "V" OPTION, C10 IS 0.01MF±10%, 1000V, PAPER.

MODELS	
LCS-D-12	LCS-D-24
LCS-D-15	LCS-D-28
LCS-D-20	LCS-D-48

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY-TO-LOAD WIRING DIAGRAMS

DOTTED CONNECTIONS INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

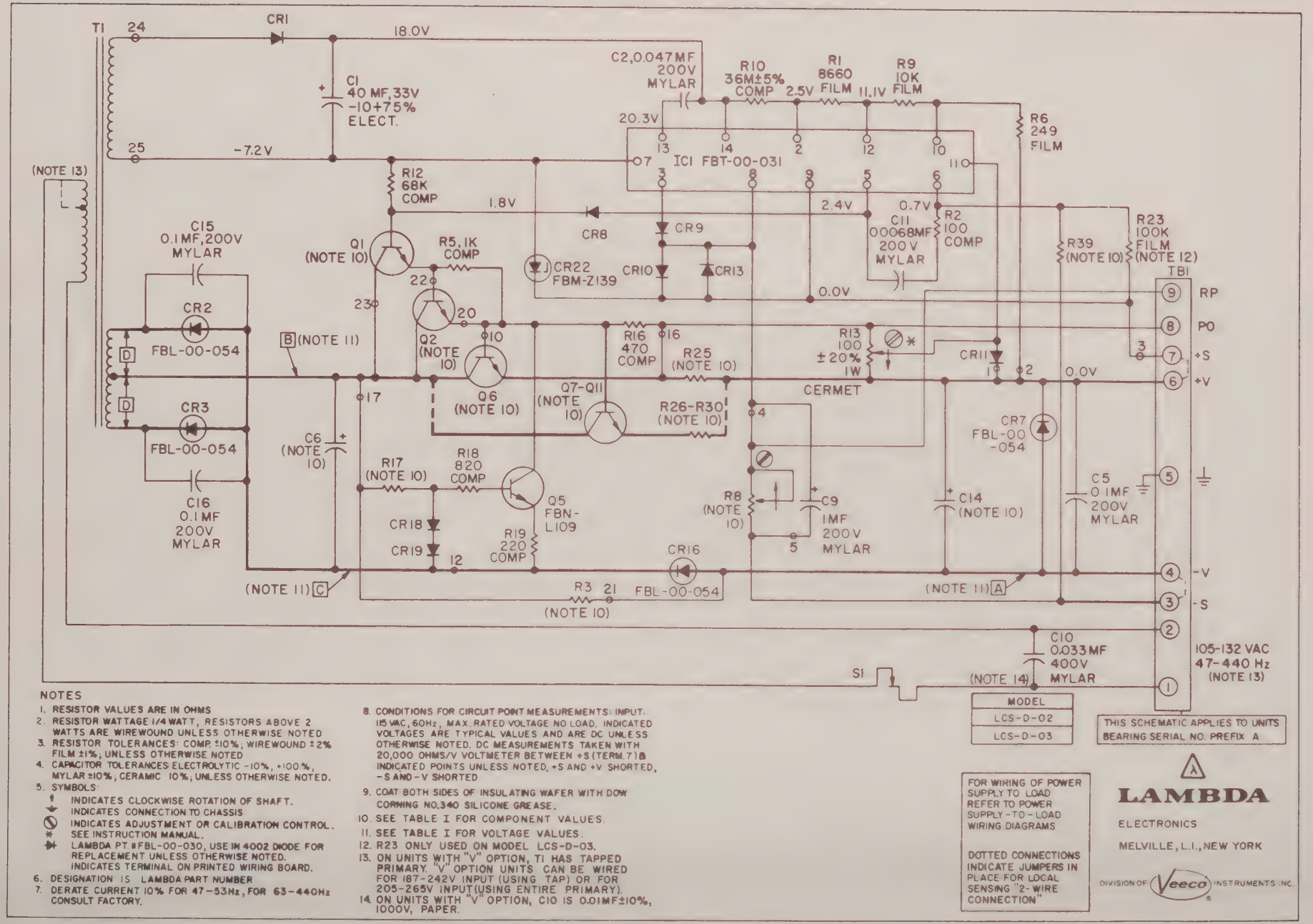
THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIX A

LAMBDA
ELECTRONICS
MELVILLE, L.I., NEW YORK
DIVISION OF Veeco INSTRUMENTS INC.

TABLE I
SCHEMATIC DATA REFERENCES
MODELS LCS-D-12 THRU LCS-D-48

Models	Schematic Voltage Measurements			Schematic Components											
				C6, C7	C14	CR8	Q1	Q2	Q8-Q11	R3	R4	R8	R20	R21	R25-R30
	A (Vdc)	B (Vdc)	C (Vac)	10+100% ELECT	10+100% ELECT	*FB1-06	*FBN	*FBN	*FBN			±5% 2 W WW	1% FILM	±1% 1-4W FILM	±5% WW
LCS-D-12	-12	12.6	17.4	22,000 mf 40 vdc	2,200 mf 35 vdc	030	L109	36485	36485	1.8K±10% 1W COMP	1.8K±10% 1W COMP	13K	9.09K ±1%	50K	0.22 5 W
LCS-D-15	15	12.8	19.6	22,000 mf 40 vdc	2,200 mf 35 vdc	030	L109	36485	36485	1.8K±10% 1W COMP	1.8K±10% 1W COMP	13K	9.09K ±1%	[illegible]	0.22 5 W
LCS-D-20	20	16.0	25.4	15,000 mf 60 vdc	1,100 mf 60 vdc	030	L109	36220	36220	2K±3% 3W WW	3.3K±5% 1W COMP	15K	15K ±5%	66.5K	0.39 5 W
LCS-D-24	24	19.2	30.6	13,000 mf 60 vdc	1,100 mf 60 vdc	030	L109	36220	36220	2K±3% 3W WW	3.3K±5% 1W COMP	15K	20K ±1%	100K	0.39 5 W
LCS-D-28	-28	20.2	34.1	13,000 mf 60 vdc	1,100 mf 60 vdc	030	L109	36220	36220	2K±3% 3W WW	3.3K±5% 1W COMP	15K	20K ±1%	120K	0.39 5 W
LCS-D-48	-48	26.0	52.4	4,000 mf 100 vdc	520 mf 100 vdc	036	L115	35902	35902	5.6K±3% 3W WW	9K±3% 3W WW	23K	40.2K ±1%	121K	[illegible] 3 W

* Lambda part no.



NOTES

1. RESISTOR VALUES ARE IN OHMS
2. RESISTOR WATTAGE 1/4 WATT, RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED
3. RESISTOR TOLERANCES: COMP. ±10%; WIREWOUND ±2% FILM ±1%; UNLESS OTHERWISE NOTED
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10%, +100%, MYLAR ±10%; CERAMIC 10%; UNLESS OTHERWISE NOTED.
5. SYMBOLS:
   - INDICATES CLOCKWISE ROTATION OF SHAFT.
   - INDICATES CONNECTION TO CHASSIS
   - INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   - SEE INSTRUCTION MANUAL.
   - LAMBDA PT. #FBL-00-030, USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED. INDICATES TERMINAL ON PRINTED WIRING BOARD.
6. DESIGNATION IS LAMBDA PART NUMBER
7. DERATE CURRENT 10% FOR 47-53Hz, FOR 63-440Hz CONSULT FACTORY.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT. 115 VAC, 60Hz, MAX. RATED VOLTAGE NO LOAD. INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED, +S AND +V SHORTED, -S AND -V SHORTED
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. SEE TABLE I FOR COMPONENT VALUES.
11. SEE TABLE I FOR VOLTAGE VALUES.
12. R23 ONLY USED ON MODEL LCS-D-03.
13. ON UNITS WITH "V" OPTION, T1 HAS TAPPED PRIMARY. "V" OPTION UNITS CAN BE WIRED FOR 187-242V INPUT (USING TAP) OR FOR 205-265V INPUT (USING ENTIRE PRIMARY).
14. ON UNITS WITH "V" OPTION, C10 IS 0.01MF±10%, 1000V, PAPER.

MODEL
LCS-D-02
LCS-D-03

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIX A

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY-TO-LOAD WIRING DIAGRAMS

DOTTED CONNECTIONS INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

A

LAMBDA

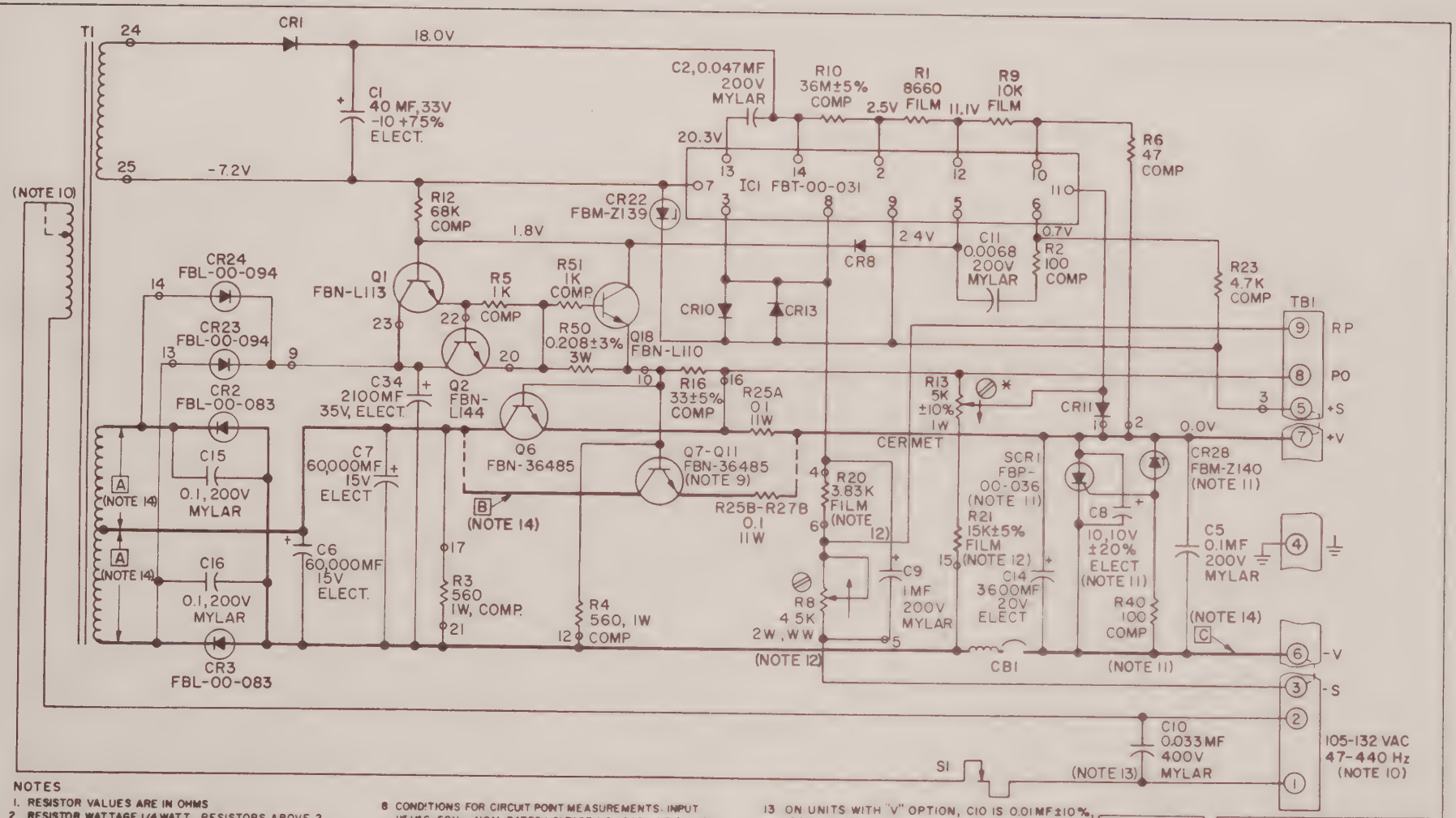
ELECTRONICS

MELVILLE, L.I., NEW YORK

DIVISION OF Veeco INSTRUMENTS INC.

TABLE I
SCHEMATIC DATA REFERENCES
MODELS LCS-D-02 AND LCS-D-03

Model	Schematic Voltage Measurements				Schematic Components									
					C6	C14	Q1	Q2	Q6 Q11	R 1	R8	R17	R25 R30	R 19
	A (Vdc)	B (Vdc)	C (Vdc)	D (Vdc)	-10+100% ELECT	10+100% ELECT	*FBN	*FBN	*FBN	1W COMP	2 W	1W COMP	5W WW	1 4W
LCS-D-02	-18	14 [illegible]	18.6	23.5	22 000 mf 40 vdc	2 100 mf 35 vdc	L109	06485	06485	1 1K ±5%	2 0K ±0.5 WW	3 3K ±5%	0.75 ±5%	1.00K ±1% FILM
LCS-D-03	-32	21.7	32 6	38 0	13 000 mf 60 vdc	1 100 mf 60 vdc	L115	06220	06220	1=K ±2%	4 0K ± [illegible] % (F R MF 1	10K ±10%	1 5 ±3%	220K ±1% COMP



NOTES

1. RESISTOR VALUES ARE IN OHMS
2. RESISTOR WATTAGE 1/4 WATT, RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED
3. RESISTOR TOLERANCES: COMP. ±10%, WIREWOUND ±5%; FILM ±1%; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10%, +100%; MYLAR ±10%, CERAMIC 10%, UNLESS OTHERWISE NOTED.
5. SYMBOLS:
   - INDICATES CLOCKWISE ROTATION OF SHAFT.
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   - LAMBDA PT #FBL-00-030, USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
   - INDICATES TERMINAL ON PRINTED WIRING BOARD.
6. DESIGNATION IS LAMBDA PART NUMBER
7. DERATE CURRENT 10% FOR 47-53Hz, FOR 63-440Hz CONSULT FACTORY.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT 115 VAC, 60Hz, NOM. RATED VOLTAGE NO LOAD. INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED; +S AND +V SHORTED, -S AND -V SHORTED.
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. ON UNITS WITH "V" OPTION T1 HAS TAPPED PRIMARY. "V" OPTION UNITS CAN BE WIRED FOR 187-242V INPUT (USING TAP) OR FOR 205-265V INPUT (USING ENTIRE PRIMARY).
11. C8, CR28, R40 AND SCR1 ONLY USED ON MODEL LCS-D-5-0V.
12. ON MODEL LCS-D-2; R20 IS 1.47K, R21 IS 6.8K±2% R8 IS 2.2K.
13. ON UNITS WITH "V" OPTION, C10 IS 0.01MF±10%, 1000V, PAPER
14. SEE TABLE I FOR VOLTAGE VALUES.

TABLE I
SCHEMATIC VOLTAGE VALUES

MODEL	A (VAC)	B (VDC)	C (VDC)
LCS-D-2	6.55	7.25	-2
LCS-D-5-0V	9.45	8.35	-5
LCS-D-6	10.20	8.40	-6

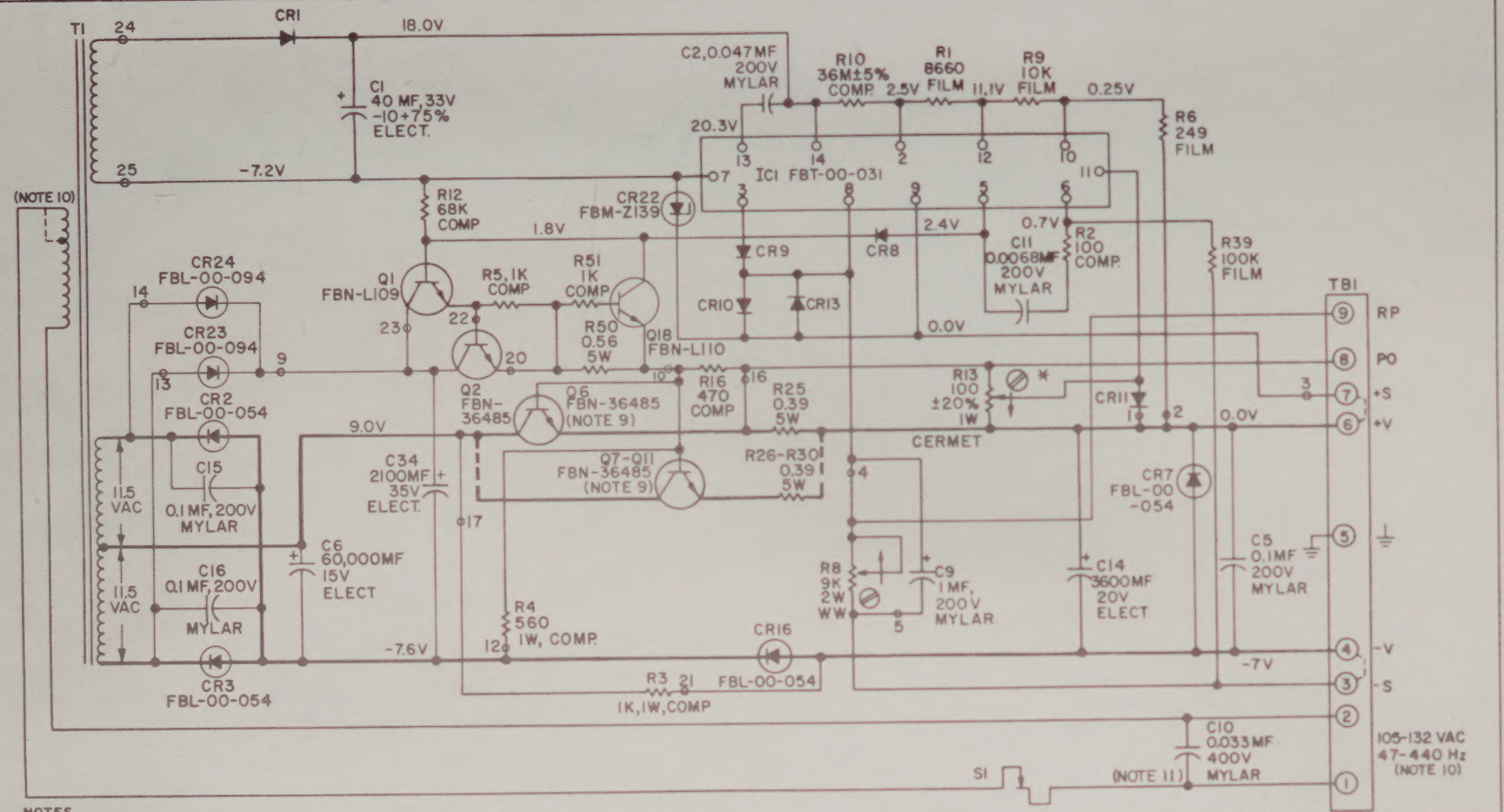
MODELS
LCS-D-2
LCS-D-5-0V
LCS-D-6

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIX A

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY-TO-LOAD WIRING DIAGRAMS

DOTTED CONNECTIONS INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

LAMBDA
ELECTRONICS
MELVILLE, L.I., NEW YORK
DIVISION OF Veeco INSTRUMENTS INC.



NOTES

1. RESISTOR VALUES ARE IN OHMS.
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3. RESISTOR TOLERANCES: COMP. ±10%; WIREWOUND ±5% FILM ±1%; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10%, +100%; MYLAR ±10%; CERAMIC 10%; UNLESS OTHERWISE NOTED.
5. SYMBOLS:
   - INDICATES CLOCKWISE ROTATION OF SHAFT.
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   - * SEE INSTRUCTION MANUAL.
   - LAMBDA PT. #FBL-00-030, USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
   - INDICATES TERMINAL ON PRINTED WIRING BOARD.
6. DESIGNATION IS LAMBDA PART NUMBER.
7. DERATE CURRENT 10% FOR 47-53Hz, FOR 63-440Hz CONSULT FACTORY.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT: 115 VAC, 60Hz, MAX. RATED VOLTAGE NO LOAD. INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED; +S AND +V SHORTED, -S AND -V SHORTED.
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. ON UNITS WITH "V" OPTION, T1 HAS TAPPED PRIMARY. "V" OPTION UNITS CAN BE WIRED FOR 187-242V INPUT (USING TAP) OR FOR 205-265V INPUT (USING ENTIRE PRIMARY).
11. ON UNITS WITH "V" OPTION, C10 IS 0.01MF±10%, 1000V, PAPER.

MODEL
LCS-D-01

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIX A

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY-TO-LOAD WIRING DIAGRAMS

DOTTED CONNECTIONS INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

LAMBDA
ELECTRONICS
MELVILLE, L.I., NEW YORK
DIVISION OF Veeco INSTRUMENTS INC.

5-Year
Guarantee
We warrant each instrument manufactured by us, and sold by us or our authorized agents, to be free from defects in material and workmanship, and that it will perform within applicable specifications for a period of five years after original shipment. Our obligation under this guarantee is limited to repairing or replacing any instrument or part thereof, (except tubes and fuses) which shall, within five years after delivery to the original purchaser, be returned to us with transportation charges prepaid, prove after our examination to be thus defective.
We reserve the right to discontinue instruments without notice, and to make modifications in design at any time without incurring any obligation to make such modifications to instruments previously sold.

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